The Rising Cost of Publishing in Aquatic Science Journals

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THE RISING COST OF PUBLISHING IN AQUATIC SCIENCE JOURNALS

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ABSTRACT

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The exchange of scientific information in the aquatic sciences in 1994 is primarily through printed research journals. The costs of this method of communication are considered in relation to its value in the dissemination of scientific information. The analysis shows that:

- there is a wide range in journal subscription costs;
- journal costs have risen at a much faster rate than the consumer price index;
- journal costs are not related to journal impact factors;
- the highest cost journals are all associated with for-profit publishers who initiated them in the 1960-70's;
- nearly all journals supply reprints at exorbitant cost.

The traditional indicators of a particular journal's value to prospective authors, such as the journal impact factor, or total number of copies distributed to potential readers, have been made obsolete by the wide use of on-line abstracting and indexing services. For this reason, it matters little in which journal an author's article appears. Hence, authors should choose to submit articles to specific journals on the basis of the journal's cost per article to the research library, as well as the individual costs (reprints and page charges), reputation and editorial policy of the journal.

RÉSUMÉ

Wildish, D. J., and M. J. Rudi. 1994. The rising cost of publishing in aquatic science journals. Can. Manuscr. Rep. Fish. Aquat. Sci. 2243: 20 p.

En 1994, l'échange d'information scientifique dans le domaine des sciences halieutiques est principalement par les publications de recherches en format imprimé. Les coûts associés à cette méthode de communication sont ici considérés quant à la valeur de celle-ci pour la propagation d'information d'ordre scientifique. L'analyse démontre que:

- il existe un grand écart dans les coûts de souscription à ces revues scientifiques;
- les coûts des publications ont augmentés beaucoup plus rapidement que l'indice des prix aux consommateurs;
- les coûts des publications ne sont pas en fonction du facteur d'impact des revues;
- les publications aux coûts les plus élevées sont toutes associées aux maisons d'éditions à profits qui ont lancées ces revues aux cours des années soixante et soixante-dix;
- la majeur partie de ces revues fournissent des réimpressions à un coût excessif.

Les indices traditionnels de la valeur d'une revue particulière aux auteurs futurs, tel que le facteur d'impact des revues ou la quantité d'exemplaires en circulation, sont tombés en désuétude à cause de l'utilisation répandu des services d'abstraction et d'indexation disponibles sur réseaux. Pour cette raison, il importe peu dans quelle publication l'article d'un auteur apparait. Les auteurs devraient alors choisir de soumettre leurs articles à des revues spécifiques d'après le coût transmis aux bibliothèques de recherches par article dans une publication, en plus des coûts aux individues tels que frais de réimpression et de publication par page, et finalement d'après la réputation et la politique éditoriale de la publication.

INTRODUCTION

Science is concerned with the creation and communication of new knowledge (e.g. ideas, opinions, tests of hypotheses, theories, field observations or succinct reviews of this knowledge) of potential use to other practising research scientists. In this presentation we are concerned with the research scientist's role and responsibility to communicate work done in aquatic sciences and fisheries studies. Obviously, communication of new scientific knowledge is a very important element in participating in the "invisible college" on which science is based. It is, therefore, not surprising that various ways have been found to maximize science communication, including personal communication, workshops, symposia, published journals and books. More recently, electronic mail and on-line discussion groups have begun to appear and may be increasingly important in the future.

Because at most research institutions, such as the St. Andrews Biological Station (SABS), a given scientist will be involved with a specialized field of work (e.g. benthic ecology, fish and invertebrate physiology, analytical chemistry and biochemistry), it may prove difficult to meet colleagues with similar interests on a one-to-one basis or in workshop settings. For specialized fields of work, the "invisible college" or audience is only sufficiently large if the wider world is considered. A consequence of this is that regularly published journals should be the most efficient, practical and cheapest way for the members of the college to keep in touch with each other's ideas and results.

Our purpose here is to reconsider the role of the research journal, and examine its value in the dissemination of scientific information in relation to its cost to the scientific community.

THE SCIENCE INFORMATION LOOP

The role of the primary science research journal in scientific communication is outlined in Fig. 1. From this we see that three different professionals are concerned with creating and communicating scientific information. They are: the *research scientist* who creates new science information, prepares a research article or report of the work and reviews articles produced by

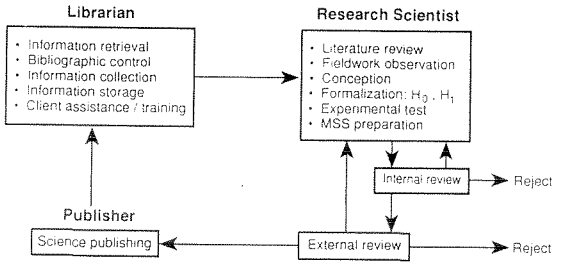

Fig. 1. The creation and communication of scientific information by the printed word.

other scientists; the *publisher* who prepares a published journal in sufficient numbers to allow wide dissemination of the research articles it contains; and the *librarian* who assists the research scientist by providing access to published information through the collection, storage and retrieval involving bibliographic control (indexing, abstracting, classification).

FUTURE WAYS OF COMPLETING THE SCIENCE INFORMATION LOOP

Recent advances in electronic publishing, using personal computers, point the way to on-line versions of science journals (Maddox 1992). An example of one of the first on-line journals is Online Journal of Current Clinical Trials, which started in July 1992 (Borman 1993). It is a peer reviewed journal published by the American Association for the Advancement of Science. Subscribers to this journal can access the complete article using a special interface. Automatic on-screen alerts inform subscribers about letters, rebuttals or retractions concerning any article they select. Articles appear on the network within 48 h of their acceptance. A hard-copy, shorter version of the article is published concurrently in the Lancet, a weekly British medical journal, following separate review.

For the short term (~5 yr), it is unlikely that among the aquatic sciences and fisheries journals an on-line version will appear. But, because it is possible that such an experiment will take place in the future, it is important for all to realize what is wanted from such a system.

For the research scientist, this is: speed in reaching the target audience, wide dissemination, and quality control (review) on new articles entering the system. For the librarian, or more properly the information specialist, it is ease of collection, storage, bibliographic control, rapid information retrieval and reasonable cost over which there is some control.

METHODS

TYPES OF SCIENTIFIC PERIODICALS

Among the ~100 periodicals currently purchased by the St. Andrews Biological Station library, there are four distinct types of publication. *Science magazines* (e.g. New Scientist, Scientific American) do not include original research articles but interpretive articles for a multidisciplinary audience on, for example, rapidly developing subfields of science. *Technology transfer journals* are specifically designed to transfer science to a commercially active field, e.g. commercial fishing or aquaculture (Northern Aquaculture, World Aquaculture, National Fishermen). Both of these types of scientific periodicals have been excluded from Appendix 1 because they do not contain original research articles. A few *multidisciplinary journals*, notably Nature and Science, contain abbreviated research articles from all fields of science (physics, chemistry, biology, medicine). The audience is typically wide (all scientists) and, like the previous two types of periodical, the journal is partly supported by subscriptions as well as by advertising revenue. Finally, primary or *single discipline journals* which constitute the bulk of those in Appendix 1, contain original research articles from, typically, a specific field, or subdiscipline, of science (e.g. marine ecology, physiology, analytical chemistry). The audience is, therefore, more restricted and journal costs are supported by subscriptions and usually not by advertising, although this is changing. In some cases, additional income to the publisher is generated by charges to an individual author for each page published in their journal, and by charges to the author for supplying reprints. We have obtained page charge and reprint cost information directly from the publishers (where possible) and include it for a subset of the journals.

ESTIMATES OF JOURNAL COST

For each of the multidisciplinary and single discipline periodicals held in the St. Andrews Biological Station library, we have counted the number of research articles for all issues for both years 1991 and 1992 (=P, the number of original research articles per year). In determining P we have excluded editorials, book reviews and conference abstracts, but have included notes, and short or rapid communications.

The subscription costs for 1991 and 1992 for each journal are calculated from invoices based on Can. $ by converting (multiplying) from foreign currencies as follows: U.S. $ = 1.20, U.K. £ = 2.00, Dutch Fl = 0.7, German DM = 0.8, Danish Kr = 0.2. The cost per article is:

$$\text{Cost/article} = \frac{\text{Journal subscription cost for year}}{P}$$

where P = # research articles per year per journal. The 1992 cost per article is used in subsequent analyses, although if this cost was not available, the 1991 value was used in its place.

ESTIMATE OF VALUE

The measure of journal value used is the *journal impact factor* (JIF) which is calculated as:

$$JIF = \frac{C}{P'}$$ (Anon. 1991 and see Costa and Sylvester 1993)

where C = number of citations per journal for 1991-92

P' = as defined in the ISI Journal Citation Report (Anon. 1991).

JIF values noted in Appendix 1 are taken from the Science Citation Index Journal Citation Reports published by ISI, 3501 Market St., Philadelphia, Pennsylvania 19104, USA. An independent estimate of the number of copies of a journal circulated was obtained either directly from the publisher, or from Ulrich's International Periodicals Directory which lists the circulation figures of scientific journals. We have included this information for 1991-93 for a subset of the journals in Appendix 2.

STATISTICAL TESTS

It was determined whether the estimates of cost were related to value on a subset of the journals by linear regression analysis.

RESULTS

GENERAL

As a prelude to presenting cost-value estimates, we show the library purchasing power at SABS for the last 10 yr (Table 1). Beginning in 1986, it was necessary to begin cancelling journal subscriptions because of a precipitous decline in library purchasing power. The reasons for this are two-fold:

(1) an astronomical rise in the cost of subscriptions to journals. We have calculated the average rise in cost over the period 1984-94 for a representative set of 19 journals (see Table 5). The average rise in subscription cost per journal is +318%.

(2) the percent change in the Canadian Consumer Price Index (Statistics Canada) over the period 1983-93 of +45% exceeds the library budget increase (Table 1), which is +13% that in 1983. Thus, the dollar value of the library budget was also declining during this period.

Up until 1985 (Table 1), an attempt was made to purchase new journals being launched. After 1985, it became impossible to do this and necessary to cancel subscriptions just to keep within budget. Nevertheless, a greater percentage of the library budget every year beginning in 1987 was committed to journal subscriptions. By 1991, special allocations (not included in the original budget shown in Table 1) were made in addition to subscription cancellations to cover the increasing costs.

One other way of supporting a burgeoning journal subscription bill was tried in which individual research scientists paid for a journal from their operating and maintenance budgets. Unfortunately, funding to research programs has also declined in the last decade (Table 2), so it is unlikely that this could become an important way to increase library purchasing power.

JOURNAL COSTS AND VALUES

Our estimates of journal costs and value are shown in Appendix 1. The latter can be used as a guide to examine questions of cost and value, although it should be pointed out that we have arbitrarily chosen 1991-92 in this presentation. The costs and value of a publication may change so the data of Appendix 1 requires regular updating.

Typical costs per article range from $0.23 (#112 and 106, Appendix 1) to $98.00 (#87, Appendix 1), a 426x range. Typical costs per article in Appendix 1 are arbitrarily classified as:

Low	<$2.50
Medium	$2.50-$5.00
High	>$5.00

Forty of the journals listed in Appendix 1 can be assigned to each of the low, medium and high groups on the basis of cost per article, with three journals where the data is absent, suggesting the eveness of this classification. Some of the high cost per article journals listed in Appendix 1 can be explained because they are exclusively for reviews. Since review articles are typically longer than most research articles, it is to be expected that review journals (e.g. Oceanography and Marine Biology Annual Review; Reviews in Environmental Contamination and Toxicology) will be in the higher cost range.

Journal impact factors shown in Appendix 1 range from 0.144 (#35 in Appendix 1) to 19.607 (#112 in Appendix 1), which is a 136x range. These values may be characterized arbitrarily as:

Low	<6.0
High	>6.0

We believe that the high impact categories are limited to journals with a very wide readership base, notably the multidisciplinary journals Science and Nature. This high impact category is clearly distinguished from single discipline journals with a more limited readership.

Table 1. St. Andrews Biological Station Library budget in the period 1983-93.

Fiscal year	Budget ($K)	Percent of budget to journals	No. of journals purchased	Consumer price index
1983	58.7	74	216	5.7
1984	61.9	78	221	4.4
1985	69.0	83	222	3.9
1986	70.0	81	172	4.2
1987	69.6	81	155	4.4
1988	65.0	87	151	4.0
1989	65.0	92	149	5.0
1990	71.1	94	147	4.8
1991	69.2	104	132	5.6
1992	68.5	107	117	1.5
1993	66.1	112	92	1.8

Table 2. St. Andrews Biological Station Contaminants and Toxicology group's budget in the period 1983-93.

Fiscal year	Person years	O&M budget ($K)	Capital budget ($K)
1983(-84)	9	150	0
1984	9	176	0
1985	8	86	0
1986	6	82	2.5
1987	6	63	0
1988	6	89	2.4
1989	7	130	172
1990	7	131	39
1991	7	130*	22
1992	7	109*	6.2
1993	7	114*	5.0

*Inclusive of B-base funds.

REPRESENTATIVE SUBSET OF JOURNALS

Selection of a subset of journals was made (Table 3) to provide a workable-sized database for further analysis. The 35 journals included in Table 3 represent the publication outlets which carried the scientific contribution of D. J. Wildish and collaborators in the period 1969-93. The subjects of the published articles included amphipod ecology, chemical and general organic pollution in the marine environment, as well as studies involving hydrodynamics in benthic ecology. From Table 3, 16 of the journals are not currently taken by the SABS library and these are excluded from further consideration because no information for them was available.

For the remaining 19 journals in Table 3, we have calculated:

(a) the cost, inclusive of reprints and page charges, to publish a 10-page article in each journal;

(b) we have multiplied (a) by the number of articles published in each journal, as shown in Table 3, to derive a total cost for publishing in that journal to an author;

(c) assuming that the 62 articles published in 19 journals represents the total 1993 SABS output for all research scientists, we have summed the total costs.

Table 3. Author costs in Canadian $ for 1993 based on a subset of journals (publications by D. J. Wildish during 1969-93). A 10-page research article and 100 reprints purchased without covers is assumed.

Research Journal	Number articles	Number free reprints	$ reprints (100)	$ reprints (total)	$ page (10) charges
Bull. Environ. Contam. Toxicol.	13	0	268	3484	0
Can. J. Fish. Aquat. Sci.	9	0	193	1737	0
J. Exp. Mar. Biol. Ecol.	6	50	490	2940	0
Can. J. Zool.	4	0	193	772	0
Crustaceana	4	50	105	420	(yes)
Helgolander Meeresunters.	3	80	54	162	0
Water Research	3	25	633	1899	0
J. Mar. Biol. Assoc. U.K.	3	100	119	0	0
Invertebr. Reprod. Dev.	3	25	299	897	0
Mar. Ecol. Prog. Ser.	3	0	217	651	0
Nature	2	0	505	1010	0
Hydrobiologia	2	50	287	574	0
Science	1	0	412	412	0
Mar. Biol.	1	0	?	?	?
Prog. Fish Cult.	1	?	109	109	900
Mar. Environ. Res.	1	25	561	561	0
Ophelia	1	50	210	210	0
J. Shellfish. Res.	1	0	149	149	780
Comp. Biochem. Physiol. B	1	100	633	0	960
Others*	16	-	-	-	-
			Overall totals $	15,987	2,640

*Other journals recently cancelled or absent in SABS Library are excluded from the overall costs.

Some qualification of these calculations are required because a few of the journals (e.g. Nature, Science and Comparative Biochemistry and Physiology B) require authors to submit an abbreviated article. Thus, the average length for the latter journals would be a 2- to 3-page article rather than the 10-page one used here.

Although the most prolific research scientists might publish 200 plus articles per year (Anon. 1992), the average might be between 2 and 3 which is close to that assumed in (c). As shown in Table 3, the overall cost for SABS authors to purchase reprints and pay page charges of 62 articles published in the journals arbitrarily selected is $15,987 plus $2,640 for page charges.

The question then is: is this a reasonable cost? Local commercial copying companies offer a similar service at $50 for 100 copies, although offprints are of better quality and reproduce photographic figures better. If we apply the (a), (b), and (c) calculations to this data, as above, we arrive at a cost to publish for all authors at SABS in 1993 of $3,100 plus $2,640 page charges. This suggests an overcharge by the publishers of ~$10,000, if an allowance of $2,887 is made to cover postal costs.

RELATIONSHIP OF JOURNAL COST TO VALUE

Using the 19 journals selected in Table 3, we have ranked them, using 1992 data from Appendix 1, by cost and value (Table 4).

Setting x = $ per article and y = impact value, we have regressed the data in Table 4. The results are: y = 7.788 - 0.977x, N=16, r^2=0.253 (Fig. 2), or with Nature and Science excluded: y = 0.881 + 0.023x, N=14, r^2=0.022. We conclude that there is no relationship between the cost and value estimates.

JOURNAL SUBSCRIPTION COSTS

The average cost of living increases starting from the fiscal year 1983-84 are shown in Table 1. We examined journal subscription increases in the same 10-yr period to 1993-94 and the results are shown in Table 5. The journals are ranked in order of cost per article

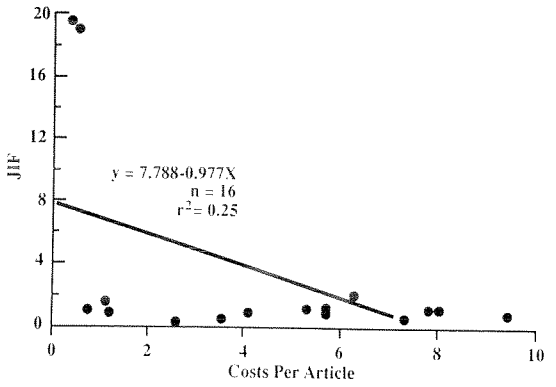

Fig. 2. Regression analysis of cost on value.

from the lowest to the highest. The year of origin of each journal is also shown. It is of interest to note that all of the high cost journals (except Ophelia) are published by for-profit publishers. In the case of Ophelia which is published by Ophelia Publications (a not-for-profit body), an unusually low number of articles appeared in 1992 (see #100, Appendix 1) and the number published in 1991 (giving a cost per article = $5.14) may be the more usual case. Of the seven low-cost journals, two, Nature and Bulletin of Environmental Contamination and Toxicology are published by for-profit organizations. For the latter, Springer publishes camera-ready copy in a no frills format which appears to be an effective form of cost control.

The range in the percentage cost increase for journal subscriptions in the 10-yr period is +132 to +829% (Table 5). The average rise in incremental costs of subscriptions in Table 5 for all 19 journals is 318%. This compares with an incremental rise in the Canadian consumer price index during the same period of 45% (Table 1).

DISCUSSION

In 1994, the traditional research journal is still the primary means of communicating scientific knowledge among members of an invisible college. During times of relative affluence in the 1960's and 1970's, a number of new journals were started (see Table 5) by commercial publishing companies in various parts of the world. These journals were usually well

Table 4. Ranking of journals in Table 3 by estimates of cost and value.

Cost			Value		
Rank	$ per article	Journal	Rank	Impact factor	Journal
1	9.43	Mar. Environ. Res.	1	19.607	Science
2	9.42	Ophelia	2	19.337	Nature
3	7.96	J. Exp. Mar. Biol. Ecol.	3	2.019	Mar. Ecol. Prog. Ser.
4	7.80	Mar. Biol.	4	1.607	Can. J. Fish. Aquat. Sci.
5	7.32	Hydrobiologia	5	1.211	Water Res.
6	6.33	Mar. Ecol. Prog. Ser.	6	1.202	Mar. Biol.
7	5.72	Water Res.	7	1.183	Invert. Reprod. Dev.
8	5.29	Invert. Rep. Dev.	8	1.157	J. Exp. Mar. Biol. Ecol.
9	4.14	J. Mar. Biol. Assoc. U.K.	9	0.939	Mar. Environ. Res.
10	3.90	Comp. Biochem. Physiol. B	10	0.929	J. Mar. Biol. Assoc. U.K.
11	3.52	Helgolander Meersunters.	11	0.845	Can. J. Zool.
12	2.56	Crustaceana	12	0.841	Ophelia
13	1.62	Prog. Fish Cult.	13	0.766	Bull. Environm. Contam. Toxicol.
14	1.21	Bull. Environm. Contam. Toxicol.	14	0.606	Hydrobiologia
15	1.10	Can. J. Fish. Aquat. Sci.	15	0.467	Helgolander Meersunters.
16	1.00	Can. J. Zool.	16	0.200	Crustaceana
17	0.83	J. Shellfish. Res.	17	?	Comp. Biochem. Physiol. B
18	0.38	Nature	18	?	Prog. Fish Cult.
19	0.23	Science	19	?	J. Shellfish. Res.

Table 5. Rank order of P' from Appendix 1 for journals shown in Table 3 with name of the publisher. Note ranking is lowest to highest so the inverse of that in Table 4. Ten-year incremental cost in Canadian $ as percentage of that in 1984.

Rank	Year of origin	Journal	Publisher	% incremental cost 1983-93	Subscription cost 1993 $
LOW					
1	1883	Science	Amer. Assoc. Advancement Science	261	358
2	1869	Nature	MacMillan Magazines Ltd.	208	573
3	1981	J. Shellfish. Res.	Nat. Shellfisheries Assoc.	829	141
4	1951	Can. J. Zool.	Nat. Res. Council of Canada	301	401
5	1901	Can. J. Fish. Aquat. Sci.	Nat. Res. Council of Canada	462	305
6	1966	Bull. Environm. Contam. Toxicol.	Springer International	222	511
7	1934	Prog. Fish Cult.	American Fisheries Society	257	573
MEDIUM					
8	1960	Crustaceana	E.J. Brill Ltd.	132	240
9	1937?	Helgolander Meersunters.	Biologische Anstalt Helgoland	143	140
10	1971	Comp. Biochem. Physiol. B	Springer International	273	2478
11	1887	J. Mar. Biol. Assoc. U.K.	Cambridge University Press	247	465
HIGH					
12	1979	Invert. Reprod. Dev.	Balabou Publishing, Israel*	303	512
13	1967	Water Res.	Pergamon Press	403	2178
14	1979	Mar. Ecol. Prog. Ser.	Interesearch	523	3691
15	1948	Hydrobiologia	Kluwer Academic Publishers	371	-
16	1967	Mar. Biol.	Springer International	366	3272
17	1968	J. Exp. Mar. Biol. Ecol.	Elsevier	207	2486
18	1964	Ophelia	Ophelia Publications	397	238
19	1979	Mar. Environ. Res.	Elsevier	143	593

*In collaboration with Int. Soc. Invertebrate Reproduction.

produced and helped to provide a sufficiently wide range of publishing outlets for the increasing number of research scientists then entering the aquatic field.

Beginning in the 1980's and continuing in the 1990's, there has been a decline both in the purchasing power of the research library (Table 1) and individual research scientists (Table 2) budgets which is partially documented here. This crunch in funding means that all costs of the scientific enterprise must be scrutinized including those associated with the science information loop. It was partly the awareness of high subscription costs of some journals that prompted this study. We have shown here that:

- there is a wide range in subscription costs of journals in the aquatic sciences/fisheries field;
- all 19 journals examined in detail have increased their subscription rates during the last decade much faster than general inflation;
- there is no relationship between cost and value (but see criticism below of our method of calculating value);
- high cost journals are invariably published by for-profit publishing companies;
- most journals overcharge for supplying reprints.

An example of the likely income generated in the production of a few journals is shown in Table 6. In the current economic climate, it is becoming increasingly difficult for libraries and individual research scientists to support million dollar plus journals and ways should be sought by the publishers to reduce their subscription prices. Unfortunately it is clear that for a commercial publisher, there is an obvious disincentive to actually reduce the subscription price since this will also reduce profit. Despite being involved with the reviewing and editorial process (e.g. D. J. Wildish editorial advisor Marine Ecology Progress Series 1989-92, editorial board Journal of Experimental Marine Biology and Ecology 1992 to date), it has proved difficult to raise issues of journal costs with the publisher. The fact is that research scientists have lost any direct say in the control of some journal subscription costs.

Table 6. Some examples of income generated from journal subscriptions and reprint sales (assuming that each author purchases 100 reprints of a 10-page long article in 1993).

	No. of copies dis-tributed	Subscription charge $	Total $	Reprints per 100 $	No. of articles published in 1992	Reprint total $
Low cost						
Can. J. Fish. Aquat. Sci.	1000	305	305,000	193	300	57,900
Medium cost						
J. Mar. Biol. Assoc. U.K.	1814	465	233,000*	119	315	37,485
High cost						
Mar. Ecol. Prog. Ser.	870	3691	3,211,170	217	362	78,554

*Approximately half of the copies distributed are given to members of the Association at no charge.

However, research libraries and the clients they support, research scientists, can by their journal purchasing and publishing practices, reduce the overall costs to the scientific enterprise (and thereby pressure the publisher to serve the interests of the client rather than only that of the share holder). Specific details of the way libraries and scientists can do this were examined by Abelson (1989) and are further explored below.

Before presenting this, we must consider the measure of value we have used in this article. In the early days of citation analyses, Garfield (1972) suggested that the correlation of data on citation frequency with subscription costs could provide a solid basis for cost-benefit analysis. We believe that the number of citations per research article is a valuable indicator for the individual research scientist and his/her peers to judge its relative importance in a particular discipline. Even here we point out that the actual number of citations per article indicating an important contribution will depend on the field, i.e. less in aquatic sciences than in medical biochemistry, for example. The problem in using citation analysis to assess the value of one journal in comparison to others is that quite often the individual journal fills a specialized area of the field. Thus, Crustaceana accepts articles on the taxonomy and natural history aspects of the ecology of a specialized group of arthropods, the crustaceans, while Marine Ecology Progress Series accepts articles of a more general ecological nature, including crustaceans (but not their taxonomy and natural history). It is of little surprise that the audience of the latter is larger than the former and, consequently, that the journal impact factor will be lower for Crustaceana. Research scientists require a mosaic of journals to adequately fill their needs. Thus, the claim by Kinne (1988) that Marine Ecology Progress Series is the premier journal in its field has a somewhat hollow ring to it. It appears to be based on citation analysis (e.g. by Garfield 1987), including journal impact factors which we have suggested here are not a useful estimate of journal value to the research scientist. Marine Ecology Progress Series certainly has one of the highest subscription rates of the subset of journals reviewed in detail here. One possible reason is that the publisher, Interresearch, financially supports the Ecology Institute - a non-profit organization which awards international prizes (Kinne 1986).

Another way to estimate the value of journals for a prospective author is to determine the current number of copies distributed to libraries, individuals, etc. as is shown for the Table 3 journals in Appendix 2. However, because of on-line abstracting services (such as Biological Abstracts, Aquatic Sciences and Fisheries Abstracts, Chemical Abstracts, Current Contents) and their wide-spread use, it renders the advantage of a copy actually reaching more readers of marginal importance.

PURCHASING STRATEGY BY THE LIBRARY

An obvious coping strategy is to focus cancellations on high cost journals (see White 1993) and to attempt to resist purchasing new journals in this category. We believe that any new journals supported by the library should be of the low-cost model, e.g. Canadian Journal of Fisheries and Aquatic Sciences, Bulletin of Environmental Contamination and Toxicology. As long as the the voluntary refereeing system (White 1993) is used, it should ensure good quality texts for publication. A recent example which has come to our attention is the new journal Amphipacifica (Vol. 1, No. 1, January 1994) with Dr. E.L. Bousfield as managing editor. Frustrated at being charged high page charges to publish monographic taxonomic data for Pacific coast amphipods, he and a few colleagues decided to publish this new journal. The editorial policy is for the author to provide an already refereed manuscript which is then photocopied during journal production. For an expected print run of 400, the cost (of 4 issues per year, ~300 pages) is $Can 50 and authors are expected to pay an additional charge of $Can 15 per page. The journal is expected to be not- for-profit but to meet expenses at these costs and print runs.

It is of interest that in the NRC Annual Report for 1992-93, it is stated that 80% of all journal production costs were recovered by sales of subscriptions. NRC publishes 13 journals including Canadian Journal of Fisheries and Aquatic Sciences (National Research Council Canada, Annual Report 1992-93).

In collaboration with the research scientist, a thorough enquiry regarding electronic publishing should also be undertaken to determine if/when this can be implemented in a way that the research scientist and librarian can keep control of the costs involved with such a system.

INDIVIDUAL RESEARCH SCIENTISTS' PUBLICATION POLICY

All of the journals used to publish articles by D. J. Wildish shown in Table 3 were chosen without regard either to the subscription cost of the journal or to the cost of reprints or page charges to the author's budget. The only criteria used were the reputation and editorial policy of the journal. In a few cases, the journal finally used represented the second choice, e.g. submissions to Nature or Science were rejected on the grounds that they were not of sufficiently general interest or lacked multidisciplinary dimensions.

We believe that in the present constrained economic conditions, prospective authors should consider: (a) the cost to the library to purchase the journal, and (b) costs to the authors' research budget in page charges and to purchase reprints, as well as (c) choosing on the basis of reputation and editorial policy. Specifically, we recommend to aspiring authors the following:

- for work which does not meet the general interests or multidisciplinary inputs required by Science or Nature, select journals only on the basis of costs. Thus, we suggest that high cost per article journals not be used whenever this is feasible. Further selection can be made on the basis of costs to the author (Table 7).

- because of uncertainties about measuring journal value and the widespread use of on-line abstracting services, we believe that the journal chosen by an author is largely irrelevant in determining whether or not the invisible college will, or will not, find this work citable.

Table 7. Rank costs (lowest to highest) in Canadian $ for a prospective author to publish a 10-page research article in journals listed in Table 3 and obtain 100 reprint copies from the publisher.

Rank	Journal	Cost of 100 reprints + page charges (asterisk)
1	J. Mar. Biol. Assoc. U.K.	0
2	Helgolander Meersunters.	54
3	Crustaceana	105(+?)
4	Can. J. Fish. Aquat. Sci.	193
5	Can. J. Zool.	193
6	Ophelia	210
7	Mar. Ecol. Prog. Ser.	217
8	Bull. Environ. Contam. Toxicol.	268
9	Hydrobiologia	287
10	Invert. Reprod. Dev.	299
11	Science	412
12	J. Exp. Mar. Biol. Ecol.	490
13	Nature	505
14	Mar. Environ. Res.	561
15	Water Res.	633
16	J. Shellfish. Res.	929*
17	Comp. Biochem. Physiol. B	960*
18	Prog. Fish Cult.	1009*
19	Mar. Biol.	?

A tempting way to reduce publishing costs is to have copies of published articles made locally at a much reduced cost. However, where authors have transferred copyright of their work to the publisher (most for-profit publishers require this), this may be illegal.

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Maddox, J. 1992. Electronic journals have a future. Nature 356: 559.

White, H. 1993. Scholarly publication, academic libraries, and the assumption that these processes are really under management control. College and Research Libraries 54: 293-301.

Appendix 1. Alphabetical list of multidisciplinary and single discipline primary journals held by SABS library in 1991 and 1992 with data on number of articles published, annual subscription cost and the journal impact factor (JIF from ISI Journal Citation Reports).

Journal	Year	No. of articles	Subscription cost US$	Cost per article, $	JIF
1. Adv. Ecol. Res.	1991	5	89.00	17.80	
	1992	13	177.00	13.61	
2. Ambio	1991	80	170.00	2.13	1.116
	1992	120	200.00	1.67	
3. Am. Fish. Soc. Publs.	1991	317	400.00	1.26	
	1992	344	400.00	1.62	
Trans. Am. Fish. Soc.)					
Fish. Bull. A.F.S.)					
N. Am. J. Fish. Manage.)					
Prog. Fish Cult.)					
4. Amer. Midl. Nat.	1991	84	60.00	0.71	0.475
	1992	86	60.00	0.70	
5. Amer. Nat.	1991	162	142.00	0.88	2.467
	1992	152	157.00	1.03	
6. Amer. Zool.*	1991	73	112.00	1.53	2.333
	1992	71	97.00	1.37	
7. Anim. Behav.	1991	260	374.00	1.44	1.636
	1992	262	374.00	1.43	
8. Appl. Environ. Microb.	1991	632	250.00	0.40	2.560
	1992	688	268.00	0.40	
9. Aquaculture	1991	270	1202.00	4.45	0.805
	1992	270	1198.40	4.44	
10. Aquacult. Eng.	1991	22	170.00	7.73	0.156
	1992	19	185.00	9.74	
11. Aquacult. Fish. Mgt.	1991	60	277.50	4.62	
	1992	73	355.00	4.86	
12. Aquat. Liv. Resour.	1991	31	170.00	5.48	
	1992	31	170.00	5.48	
13. Arch. Fischereiwiss.	1991	3	?		0.400
	1992	3	?		
14. Arch. Hydrobiol.	1991	83	487.00	5.87	0.710
	1992	69	675.00	9.78	
15. Arch. Environ. Contam. Toxicol.	1991	170	449.00	2.64	1.519
	1992	141	469.00	3.33	
16. Atmosphere - Ocean	1991	39	59.00	1.51	1.270
	1992	30	59.00	1.97	
17. Aust. J. Mar. Freshwater Res.	1991	52	180.00	3.46	0.603
	1992	113	180.00	1.59	
18. Behav. Ecol. Sociobiol.	1991	107	901.00	8.42	1.902
	1992	112	831.00	7.42	
19. Behaviour	1991	68	220.00	3.24	1.188
	1992	65	264.00	4.06	
20. Biol. Rev. Camb. Philos. Soc.	1991	14	108.00	7.71	
	1992	15	121.00	8.07	

Journal	Year	No. of articles	Subscription cost US$	Cost per article, $	JIF
21. Biometrics	1991	118	80.00	0.68	1.100
	1992	86	80.00	0.93	
22. Biometrika	1991	107	84.00	0.79	0.829
	1992	95	79.00	0.83	
23. Bioscience	1991	90	127.00	1.41	1.803
	1992	91	127.00	1.40	
24. Bull. Environm. Contam. Toxicol.	1991	284	338.00	1.19	0.766
	1992	279	338.00	1.21	
25. Bull. Mar. Sci.	1991	137	170.00	1.24	0.517
	1992	93	170.00	1.83	
26. Bull. Jap. Soc. Sci. Fish.	1991	349	514.00	1.47	0.348
(Nippon Suisan Gakk)	1992	358	366.00	1.02	
27. Can. J. Fish. Aquat. Sci.	1991	311	252.00	0.81	1.607
	1992	300	330.00	1.10	
28. Can. J. Physiol. Pharmacol.	1991	279	275.00	0.99	1.337
	1992	284	325.00	1.14	
29. Can. J. Zool.	1991	436	310.00	0.71	0.845
	1992	338	338.00	1.00	
30. Chem. Ecol.	1991	18	695.00	38.61	
(not rec'd)	1992		948.00	-	
31. Chemometrics Intelligent Lab.Sys.	1991	81	733.00	9.05	0.640
	1992	97	645.00	6.65	
32. Comp. Biochem. Physiol. A	1991	373	1500.00	4.02	
	1992	383	1630.00	4.26	
33. Comp. Biochem. Physiol. B	1991	362	1580.00	4.36	
	1992	420	1640.00	3.90	
34. Comp. Biochem. Physiol. C	1991	283	950.00	3.35	
	1992	293	1150.00	3.92	
35. Continental Shelf Res.	1991	87	420.00	4.83	0.144
	1992	70	536.00	7.66	
36. Copeia	1991	132	65.00	0.49	0.523
	1992	150	90.00	0.60	
37. Crit. Rev. Environ. Control	1991				
	1992				
38. Crustaceana	1991	64	160.00	2.50	0.200
	1992	70	179.00	2.56	
39. Deep Sea Res. Oceanogr.	1991	140	1370.00	9.78	2.052
Abstracts (price includes abst.)	1992	118	1690.00	14.32	
40. Ecol. Modelling	1991	117	684.00	5.85	0.601
	1992	84	675.00	8.03	
41. Ecol. Monographs	1991	20	53.00	2.65	4.757
	1992	20	45.00	2.25	
42. Ecology	1991	247	170.00	0.69	2.588
	1992	246	170.00	0.69	
43. Ecotoxiol. Environ. Safety	1991	67	200.00	2.99	1.155
	1992	65	214.00	3.29	

Journal	Year	No. of articles	Subscription cost US$	Cost per article, $	JIF
44. Environ. Biol. Fishes	1991	110	654.00	5.95	0.745
	1992	131	616.00	4.70	
45. Environ. Pollut.	1991	116	999.00	8.61	1.094
	1992	133	1032.00	7.76	
46. Environ. Sci. Technol.	1991	299	345.00	1.15	2.904
	1992	401	416.00	1.04	
47. Estuarine Coastal Shelf Sci.	1991	85	456.00	5.36	1.032
	1992	86	484.00	5.63	
48. Experientia	1991	152	522.00	3.43	1.580
	1992	182	522.00	2.87	
49. Fish Physiol. Biochem.	1991	39	235.00	6.03	1.671
	1992	51	235.00	4.61	
50. Fish. Res.	1991	58	300.00	5.17	0.202
	1992	73	298.00	4.07	
51. Freshwater Biol.	1991	47	472.00	10.04	1.094
	1992	116	499.00	4.30	
52. Gen. Comp. Endocrinol.	1991	203	548.00	2.70	1.776
	1992	218	584.00	2.68	
53. Helgol. Meeresunters.	1991	21	120.00	5.71	0.467
	1992	34	120.00	3.52	
54. Hydrobiologia	1991	462	3381.00	7.32	0.606
(cancelled in '92)	1992		3097.00		
55. ICES J. Mar. Sci.	1991	34	90.00	2.65	0.829
(was J. Conseil.)	1992	47	154.00	3.28	
56. Intelligent Instrum. Computers	1991	21	122.00	5.81	
(not rec'd)	1992		148.00		
57. Invertebr. Reprod. Dev.	1991	57	298.00	5.23	1.183
	1992	59	312.00	5.29	
58. J. Anim. Ecol.	1991	69	251.50	3.72	2.467
	1992	72	270.00	3.75	
59. J. Assoc. Analyt. Chem.	1991	146	190.00	1.30	1.101
	1992	155	160.00	1.03	
60. J. Biol. Rhythms	1991	26	110.00	4.23	
(cancelled in '92)	1992		145.00		
61. J. Chemometrics	1991	36	280.00	7.77	
	1992	25	335.00	13.40	
62. J. Comp. Physiol. Part A	1991	132	1081.00	8.19	1.629
	1992	146	996.00	6.82	
63. J. Comp. Physiol. Part B	1991	102	1081.00	10.60	1.372
	1992	101	996.00	9.86	
64. J. Crustacean Biol.	1991	60	90.00	1.50	
	1992	67	90.00	1.34	
65. J. Exp. Biol.	1991	243	775.00	3.19	
	1992	252	850.00	3.37	
66. J. Exp. Mar. Biol. Ecol.	1991	175	1612.00	9.21	1.157
	1992	187	1489.00	7.96	

Journal	Year	No. of articles	Subscription cost US$	Cost per article, $	JIF
67. J. Exp. Zool.	1991	188	1170.00	6.22	1.241
	1992	215	1640.00	7.63	
68. J. Fish Biol.	1991	218	588.00	2.70	0.836
	1992	211	623.00	2.95	
69. J. Fish Dis.	1991	77	375.00	4.87	0.531
	1992	67	390.00	5.82	
70. J. Freshwater Ecol.	1991	52	50.00	0.96	
	1992	46	60.00	1.30	
71. J. Gen. Physiol.	1991	114	175.00	1.53	5.111
	1992	99	190.00	1.92	
72. J. Ichthyol.	1991	132	836.00	6.33	
	1992	104	967.00	9.30	
73. J. Insect Physiol.	1991	106	795.00	7.72	1.261
	1992	115	864.00	7.51	
74. J. Mar. Biol. Assoc. U.K.	1991	64	295.00	4.61	0.929
	1992	76	315.00	4.14	
75. J. Mar. Res.	1991	34	60.00	1.76	2.014
	1992	28	60.00	2.14	
76. J. Molluscan Stud.	1991	78	130.00	1.66	0.813
	1992	48	150.00	3.12	
77. J. Northwest Atl. Fish. Sci.	1991	7	8.00	1.14	
	1992	27	8.00	0.29	
78. J. Plankton Res.	1991	105	225.00	2.14	1.324
	1992	117	295.00	2.52	
79. J. Phys. Ocean.	1991	119	205.00	1.72	
	1992	112	205.00	1.83	
80. J. Res. Nat. Inst. Standards, Hazards & Technol.*	1991	37	16.00	0.44	
	1992	19	28.00		
81. J. Shellfish Res.	1991	57	70.00	1.23	
	1992	60	50.00	0.83	
82. J. World Aquacult. Soc.	1991	34	81.00	2.38	
	1992	42	81.00	1.93	
83. J. Zool.	1991	155	685.00	4.42	0.831
	1992	156	750.00	4.81	
84. Limnol. Oceanogr.	1991	167	150.00	0.90	2.514
	1992	117	150.00	1.28	
85. Malacologia (not rec'd)	1991	11	35.00	3.18	0.686
	1992				
86. Malacol. Rev.	1991	9	33.00	3.67	
	1992	13	33.00	2.54	
87. Mar. Behav. Physiol.	1991	15	1470.00	98.00	0.484
	1992	15	908.00	60.53	
88. Mar. Biol.	1991	201	1969.00	9.79	1.202
	1992	239	1864.00	7.80	
89. Mar. Chem.	1991	133	553.00	4.16	1.455
	1992	72	675.00	9.38	
90. Mar. Ecol. Prog. Ser.	1991	320	2564.00	8.01	2.019
	1992	362	2272.00	6.28	

Journal	Year	No. of articles	Subscription cost US$	Cost per article, $	JIF
91. Mar. Environ. Res.	1991	42	396.00	9.43	0.939
	1992	76	430.00	5.65	
92. Mar. Pollut. Bull.	1991	72	270.00	3.75	1.495
	1992	61	296.00	4.85	
93. Microb. Ecol.	1991	45	222.00	4.93	1.600
	1992	45	229.00	5.09	
94. Nature	1991	-	295.00	-	19.337
	1992	1033	395.00	0.38	
95. Netherlands J. Sea Res.	1991	43	108.00	2.51	0.628
	1992	59	108.00	1.83	
96. New Zealand J. Mar.	1991	41	160.00	3.90	0.296
Freshwater Res.	1992	41	160.00	3.90	
97. Oceanogr. Mar. Biol. Ann. Rev.	1991	8			
(have not rec'd)	1992	-			
98. Oecologia	1991	295	2188.00	7.42	1.596
(cancelled)	1992	-	2021.00		
99. Oikos	1991	148	320.00	2.16	1.494
	1992	172	389.00	2.26	
100. Ophelia	1991	35	180.00	5.14	0.841
	1992	21	198.00	9.42	
101. Pestic. Biochem. Physiol.	1991	95	318.00	3.35	1.628
	1992	78	365.00	4.68	
102. Pestic. Outlook	1991	46	120.00	2.61	
	1992	28	120.00	4.29	
103. Pestic. Sci.	1991	122	472.00	3.87	
	1992	159	526.00	3.31	
104. Physiol. Rev.	1991	31	200.00	6.45	19.123
	1992	27	260.00	9.63	
105. Physiol. Zool.	1991	81	169.00	2.09	1.599
	1992	71	187.00	2.63	
106. Proc. Biol. Soc. Wash.	1991	132	30.00	0.23	
	1992	?	30.00	-	
107. Proc. Gulf Caribb. Fish. Inst.	1991	48	30.00	0.63	
	1992	47	30.00	0.64	
108. Q. Rev. Biol.	1991	9	65.00	7.22	
	1992	7	74.00	10.57	
109. Rev. Aquat. Sci.	1991	29	410.00	14.13	
	1992	18	529.00	29.39	
110. Rev. Environ. Contam. Toxicol.	1991	18	477.00	26.50	
	1992	28	506.00	18.07	
111. Sarsia	1991	22	85.00	3.86	0.478
	1992	28	88.00	3.14	
112. Science	1991	-	196.00	-	19.607
	1992	871	196.00	0.23	
113. Syst. Zool.	1991	42	40.00	0.95	3.434
	1992	40	40.00	1.00	
114. Technometrics*	1991	?	30.00	-	1.179
	1992	30	40.00	1.33	

Journal	Year	No. of articles	Subscription cost US$	Cost per article, $	JIF
115. Theor. Popul. Biol.	1991	37	248.00	6.70	0.859
	1992	42	266.00	6.33	
116. Tissue & Cell	1991	80	328.00	4.10	0.874
	1992	85	394.00	4.64	
117. Toxicol. Appl. Pharmacol.	1991	249	645.00	2.59	2.328
	1992	222	690.00	3.11	
118. Toxicon	1991	139	605.00	4.35	1.458
	1992	163	728.00	4.47	
119. Trends Anal. Chem.	1991	59	422.00	7.15	1.015
	1992	69	396.00	5.74	
120. Trends Pharmacol. Sci.	1991	112	417.00	3.72	
	1992	89	382.00	4.29	
121. Water Air Soil Pollut.	1991	243	1173.00	4.83	0.742
	1992	153	905.00	5.92	
122. Water Res.	1991	191	895.00	4.69	
	1992	200	1144.00	5.72	1.211
123. Wildl. Soc. Publ.	1991	190	100.00	0.53	
J. Wildl. Manage.	1992	180	150.00	0.83	0.770
Wildl. Monographs					2.667
Wildl. Soc. Bull.					0.565

*Incomplete - issues missing.

Appendix 2. Rank by average number of copies circulated in the 1991-93 publication years for journals shown in Table 3.

Rank	Journal	No. of copies
1	Science	159,344
2	Nature	55,000
3	Water Res.	3,800
4	Prog. Fish Cult.	3,100
5	J. Mar. Biol. Assoc. U.K	1,814
6	J. Shellfish Res.	1,400
7	Can. J. Zool.	1,260
8	Bull. Environm. Contam. Toxicol.	1,100
9	Can. J. Fish. Aquat. Sci.	1,000
10	J. Exp. Mar. Biol. Ecol.	1,000
11	Mar. Environ. Res.	1,000
12	Mar. Ecol. Prog. Ser.	870
13	Comp. Biochem. Physiol. B	836
14	Helgol. Meeresunters.	750
15	Crustaceana	700
16	Hydrobiologia	600
17	Ophelia	500
18	Invert. Reproduct. Dev.	400
19	Mar. Biol.	?