If funders and libraries subscribed to open access: The case of eLife, PLOS, and BioOne

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Abstract

Following on recent initiatives in which funders and libraries directly fund open access publishing, this study works out the economics of systematically applying this approach to three biomedical and biology publishing entities by determining the publishing costs for the funders that sponsored the research, while assigning the costs for unsponsored articles to the libraries. The study draws its data from the non-profit biomedical publishers eLife and PLOS, and the nonprofit journal aggregator BioOne, with this sample representing a mix of publishing revenue models, including funder sponsorship, article processing charges (APC), and subscription fees. This funder-library open access subscription model is proposed as an alternative to both the closed-subscription model, which funders and libraries no longer favor, and the APC open access model, which has limited scalability across scholarly publishing domains. Utilizing PubMed filtering and manual-sampling strategies, as well as publicly available publisher revenue data, the study demonstrates that in 2015, 86 percent of the articles in eLife and PLOS acknowledged funder support, as did 76 percent of the articles in the largely subscription journals of BioOne. Twelve percent of the articles identified the NIH as a funder, 8 percent identifies other U.S. government agencies. Approximately half of the articles were funded by non-U.S. government agencies, including 1 percent by Wellcome Trust and 0.5 percent by Howard Hughes Medical Institute. For 17 percent of the articles, which lacked a funder, the study demonstrates how a collection of research libraries, similar to the one currently subscribing to BioOne, could cover publishing costs. The goal of the study is to inform stakeholder considerations of open access models that can work across the disciplines by (a) providing a cost breakdown for direct funder and library support for open access publishing; (b) positing the use of publishing data-management organizations (such as Crossref and ORCID) to facilitate per article open access support; and (c) proposing ways in which such a model offers a more efficient, equitable, and scalable approach to open access than the prevailing APC model, which originated with biomedical publishing.

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Introduction

Biomedical research stands apart from other research fields for a number of reasons, including the high levels of research funding provided by government agencies and private foundations (to be referred to collectively as "funders") and these organizations' leadership in open access publishing. The funders of biomedical research have led in establishing open access mandates for the work they sponsor to ensure that this research is made publicly available [1]. In addition, the U.S. National Institutes of Health (NIH), the largest of these research funders, supports a publicly accessible index to biomedical research that identifies open access articles, as one of its National Center for Biotechnology Information programs to advance biomedical research [2]. On the journal front, the Howard Hughes Medical Institute (HHMI), Wellcome Trust, and the Max Planck Society launched eLife in 2012, an innovative open access biomedical journal, while five years earlier, the Bill and Melinda Gates Foundation supported the founding of the open access *PLOS Journal of Neglected Tropical Diseases* [3].

The biomedical field is also notable, in this regard, for how the publishers BioMed Central and PLOS pioneered not long after the turn of the century what has proven to be the most successful economic model to date for open access in biomedical publishing, namely, the "article processing charge" (APC), which authors or their institutions pay on the acceptance of a paper for publication [4]. The APC has encouraged many other publishers in this field to offer open access options and journals, including Springer Nature, Royal Society, and Elsevier, while research funders treat the APC as an allowable expense for researchers. The APC, however, appears subject to the same aggressive pricing strategies that beset journal subscription fees; it remains out of reach for many researchers and scholars working in areas that are not as well funded or working outside of the Global North; it has given rise to so-called predatory journals [5-7].

In recent years, two promising variations on the APC open access model have emerged. The Gates Foundation's Chronos program is set up to pay APCs for Gates-sponsored research in any of 24,000 journals with open access options [8]. SCOAP3 (Sponsoring Consortium for Open Access Publishing in Particle Physics) has assembled 3,000 research libraries that collectively pay the equivalent of an APC for all of the articles published in eleven particle physics journals

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[9]. The direct involvement of funders and libraries in financing open access publishing suggests a new path for increasing access to research, one that may be scaleable, and on a more equitable basis, a way that APCs are not. To explore its viability, in what follows we demonstrate a variation in which funders and libraries complement each other's contribution to establishing universal open access by having funders pay publishers to publish the research they sponsor, while libraries cover the costs of un-sponsored articles.

Method

We have chosen to apply this model to the publications of three non-profit organizations in scholarly communication: the publishers eLife and PLOS and the journal aggregator BioOne. The three, representing 198 journals in 2015, form a natural starting point for working out the terms of such a model given (a) their mix of subscription and open access; (b) their non-profit pursuit of a public good (and their posting of IRS Form 990 statements of publishing revenue); (c) their involvement of funders or libraries in their very origins; and (d) their record of leadership and innovation in a field.

The NIH's indexing service PubMed was used to identify the research sponsorship of articles that appeared in 2015 in eLife, PLOS, and the 23 of the 190 journals in BioOne journals that it indexes. The "journal article" filter was applied to ensure a count that included articles and not editorials, letters, etc. Custom filters were used to identify articles that listed "NIH grant number," "Howard Hughes grant number," and/or "Wellcome grant number" (as the three substantial biomedical research funders of particular interest to this study). As well, under the "customize" menu for "Article types," we ran both "Research Support: U.S. Gov't" and "Research Support: Non-U.S. Gov't."

With the 167 BioOne journals that had 10 or fewer articles indexed in PubMed, the funders were determined by sampling 350 articles from 20 of the journals. Examples of U.S. government support, in addition to the NIH, include the U.S. Agency for International Development, U.S. Centers for Disease Control and Prevention, National Science Foundation, the President's Emergency Plan for AIDS Relief, and U.S. Department of Veterans Affairs. The

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non-U.S. government category involves thousands of funders beyond HHMI and Wellcome Trust (Table 1).

Table 1. Examples of organizations included under Pubmed's "non-U.S. gov't" funder category.

American Asthma Foundation	J. David Gladstone Institutes
Andrew W. Mellon Foundation	Janssen Pharmaceuticals Inc.
Australian Commercial-Ready Proof of Concept Grants	Korean Ministry of Health and Welfare
Department of Health (UK)	Investissement d'Avenir (France)
Bill & Melinda Gates Foundation	Rosetrees Trust
Bristol-Myers Squibb	Royal Society
European Centre for Disease Prevention and Control	Sandler Foundation
European Community Marie Curie Actions	South African Medical Research Council
Fundación Ramón Areces (Spain)	ViiV Healthcare
Heart and Stroke Foundation (Canada)	William and Flora Hewlett Foundation

A good number of articles had more than one funder, and the funders will ultimately decide how they wish to assign and divide up publishing costs (based on such factors as amount awarded and number of articles to be credited). Authors would then identify the relevant funders on submitting articles for publication. For the purposes of this study and as an example of how this might be handled, each funder was assigned a share of the publisher's costs (based on the publisher's 2015 revenue) proportionate to the number of articles that credited a funder. The libraries will similarly decide, in conjunction with the funders, how they will cover articles without sponsorship. For this study, a collection of research libraries is employed, based on BioOne's current subscription count of 1,500 "academic libraries, research institutions, governmental bodies, NGOs and corporations," according to its website (May 1, 2017). We assumed that, in the spirit of the 3,000 SCOAP3 libraries (many of which are likely BioOne subscribers), the libraries that are currently paying for closed-subscription access to the BioOne collection will be willing to "subscribe" to open access for the unsponsored articles from among this larger set of journals.

It should also be noted that the practical feasibility of this funder-and-library-pay model has been greatly increased by the growth of the publishing industry organizations, Crossref and

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ORCID. Crossref has 3,600 scholarly publisher-members representing 40,000 journals for which it collects bibliometric metadata, while its Open Funder Registry lists some 10,000 research funders [10]. ORCID provides a growing registry of currently 3.5 million researchers, along with information on their universities and their funders. Both of these organizations have automated systems in place that are highly efficient at collecting data and metadata. These services could be extended to provide a means of verifying journals, grants, and grant-holders, as well invoicing the appropriate parties on publication, including the libraries.

Results

eLife

Launched in 2012, with an initial pledge of $26 million by HHMI, Wellcome Trust, and the Max Planck Society, eLife was intended to be, as expressed by Mark Walport, director of the Wellcome Trust, "absolute top-tier of a scientific publications, the very best" published "for scientists by scientists" [11]. It is led by editor-in-chief Randy Schekman, a cell biologist and Nobel Prize laureate at the University of California, Berkeley. In 2016, these three sponsoring organizations announced a second round of funding of $35.4 million, intended to carry it through to 2021 [12]. On January 1, 2017, the journal began levying an APC of $2,500 [13]. Even with the APC, eLife represents a particularly striking example of a cooperative venture among funders, a research institute, and a journal that has influenced the thinking behind the model presented here.

In 2015, eLife published 956 articles, according to PubMed, with 86 percent of them crediting one or more sponsors. The NIH was identified by 39 percent of the articles, HHMI by 10 percent, and Wellcome Trust by 7 percent (Table 2). In addition to these three funders, other unspecified US government agencies account for 3 percent of the sponsored articles and non-U.S. government funders for 43 percent of the credits.

Table 2. eLife articles by sponsor with proposed expense share for 2015.

	Articles	Expense share

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Sponsored articles	821 (86%)	$4,678,961
Unsponsored articles	135 (14%)	$769,379
Total articles	956 (100%)	$5,448,340
Article sponsorship (*n* = 821)		
NIH	464 (39%)	$1,809,198
Other US gov't funders	32 (3%)	$124,772
HHMI	114 (10%)	$444,501
Wellcome Trust	79 (7%)	$308,032
Other non-US gov't funders	511 (43%)	$1,992,458
Total	1,200 (100%)	$4,678,961

The publishing expenses were calculated using eLife's reported costs at $5,600 an article in 2015 [14]. The funders' share was calculated by dividing the costs of the 821 articles by the proportion of articles for which the funder is credited (Table 2). It should be noted that eLife's reported cost of $5,600 does not take into account expenses associated with developing the platform and other technical innovations, such as the Lens article-display technology (released as open source software), with costs of these developments placed at around two million dollars annually, according to Paul Kelley (personal correspondence 2016 Mar 4) [15-16]. These development costs do not figure in these calculations, and seem appropriately assigned to eLife's original endowment, with the results of this investment in technology benefiting all publishers through the open source software model followed by eLife. Funder support for technical innovation will play an important role in this model's scalability and its improving of publishing quality.

Given that there are at least 1,200 funder and funder category credits listed by the 821 eLife articles with a sponsor, each funder will be invoiced for a maximum of $3,899 of the $5,600 required by an article (Table 3). The actual figure will be less than this $3,899, given that the number of articles identified with "US gov't" (3 percent) and "non-US gov't" (43 percent) have at least one funder from those categories but may actually have more than one from that category sharing the cost of the article.

As for the 135 articles that did not have a sponsor, representing 14 percent of the 2015 output, their publishing costs are to be covered in this model by the research library community.

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With 1,500 institutions in place, following the BioOne example, this works out to a charge of $513 per library, or $3.80 per article. It may well seem odd to ask libraries to start paying for – or "subscribing" to – open access with eLife, where they have not previously paid, and we address this below with the example of BioOne where they will pay much less than they are currently paying.

Table 3. Existing and projected eLIfe publishing and expense structure for 2015.

	eLife
Journals	1
Articles	956
Cost/article	$5,699[a]
Total cost	$5,448,340
PROJECTED	
Funder article credits	1,200
Funders' share	$4,678,961
Funder fee/article	$3,899
Unsponsored articles	135 (14%)
Libraries' share	$769,379
Individual library share	$513
Library fee/article	$3.80

[a] Expense reported by eLife for 2015.

With its introduction of an APC in 2017, eLife has recognized the need for a sustainability model that is shared by more funders (through research grants used for APCs) than the three original funders who directly supported its operations. The model proposed here offers another means of rationalizing a broader and more precisely calculated form of support from among the funders who sponsor the work that appears in the journal.

PLOS

PLOS is another publisher that, in its origins, brings the funders into the publishing picture. One of PLOS' three founders, Harold Varmus, was director of NIH from 1993-99, during which time he pursued greater public access for biomedical literature. After considerable

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pushback from the publishing industry, PubMed Central was established by the NIH in 2000 as an open access repository based on voluntary submissions, demonstrating the funder's direct investment in advancing access to and the quality of scholarly communication, principally through National Center for Biotechnology Information. That same year, Varmus joined with Pat Brown and Michael Eisen to form the the Public Library of Science (PLOS), launching *PLOS Biology* in 2003, with six journals added since then, all relying on an APC to finance open access (Table 4). Six of the journals are squarely in the field of biomedical research, while the seventh *PLOS One*, the original "mega-journal" (with over 28,000 articles in 2015), reaching across the sciences and beyond [17].

Table 4. PLOS article processing charges (APC) by journal (2015).

Journal	APC
PLOS Medicine	$2,900
PLOS Biology	$2,900
PLOS Computational Biology	$2,250
PLOS Pathogens	$2,250
PLOS Genetics	$2,250
PLOS Neglected Tropical Diseases	$2,250
PLOS One	$1,495

In 2015, the NIH was credited by 38 percent of the sponsored articles in *PLOS Pathogens* and *PLOS Genetics*, both of which had well over 90 percent of their articles funded, as did *PLOS Computational Biology* (Table 5). Despite its relatively unrestricted research focus, *PLOS One* had 14 percent of its sponsored articles acknowledge NIH support, with 85 percent identifying a funder of some sort; it also had a high level of participation, relative to the other journals in this study, from non-U.S. government funders (70 percent). Even with the lower APC, these figures suggest that *PLOS One* attracts studies with funding from the broader range of sciences.

Table 5. Distribution of articles by journal and funders for PLOS journals in 2015.

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	Medicine	*Biology*	*Comp. Bio.*	*Pathogens*	*Genetics*	*N. Trop. D.*	*One*
Sponsored articles	109 (84%)	192 (72%)	581 (94%)	665 (94%)	747 (96%)	688 (85%)	24,219 (85%)
Unsponsored articles	21 (16%)	74 (28%)	35 (6%)	43 (6%)	34 (4%)	123 (15%)	4,118 (15%)
Total articles	130 (100%)	266 (100%)	616 (100%)	708 (100%)	781 (100%)	811 (100%)	28,337 (100%)
Article sponsorship							
NIH	40 (28%)	76 (30%)	216 (29%)	343 (38%)	381 (38%)	163 (20%)	3,838 (14%)
Other US gov't	6 (4%)	16 (6%)	53 (7%)	21 (2%)	30 (3%)	36 (4%)	775 (3%)
HHMI	4 (3%)	5 (2%)	6 (1%)	23 (3%)	27 (3%)	0 (0%)	73 (0.5%)
Wellcome Trust	27 (19%)	18 (7%)	439 (3%)	61 (7%)	44 (4%)	86 (11%)	322 (2%)
Other non-US gov't	68 (47%)	139 (55%)	427 (59%)	453 (50%)	534 (53%)	526 (65%)	21,679 (78%)
Total	145 (100%)	254 (100%)	739 (100%)	901 (100%)	1,016 (100%)	811 (100%)	26,687 (100%)

The non-U.S. government funders (other than HHMI and Wellcome Trust) will collectively pick up the publishing expenses associated with 78 percent of the articles that PLOS published in 2015 (Table 6). PLOS' revenue of $42,274,910, as declared on its 2015 tax form, resulted from publishing 31,656 articles that year. This amounts to an average income of $1,335 per article (Table 7). While $1,335 is less than PLOS' lowest APC rate of $1,495, 5 percent of articles in 2015 were granted an APC waiver ("support provided to authors"), while other items may have been published without an APC.

Table 6. PLOS articles by sponsoring funder with proposed distribution of expenses for 2015.

	All 7 PLOS journals	Expense share
Sponsored articles	27,207 (86%)	$36,333,649
Unsponsored articles	4,449 (14%)	$5,941,261
Total articles	31,656 (100%)	42,274,910
Article sponsorship (*n* =27,207)		
NIH	5,059 (17%)	$6,014,776
Other US gov't	937 (3%)	$1,114,387
HHMI	138 (0.5%)	$164,205
Wellcome Trust	584 (2%)	$693,772
Other non-US gov't	23,841 (78%)	$28,346,509
Total	30,559 (100%)	$36,333,649

The funders' contribution for sponsored articles will be no more than $1,189 per article and likely less than that, given some articles having multiple funders in the US gov't and non-US

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gov't categories. The libraries' share for unsponsored articles in the seven journals is $5,941,261, which works out to $3,961 per library annually among the assumed community of 1,500 institutions and $0.89 an article (Table 7).

Table 7. Existing and projected PLOS revenue and expense structure for 2015.

	PLOS
Journals	7
Articles	31,656
Revenue/article	$1,335
Revenue total	$42,274,910[a]
PROJECTED	
Funder article credits	30,559
Funders' share	$36,333,649
Funder fee/article	$1,189
Unsponsored articles	4,449 (14%)
Libraries' share	$5,941,261
Individual library share	$3,961
Library fee/article	$0.89

[a] IRS Form 990, 2015, publication income.

BioOne

BioOne is the "product of innovative collaboration between scientific societies, libraries, academe and the private sector," according to its website. It was founded in 1999, "by both library and publisher interests to address the inequities posed by commercial journal publishing." In 2015, it was the home of 190 journals or books series (which are treated as journals for purposes of this study) from 140 scholarly societies in the field of biology. BioOne is a secondary or ancillary publisher offering a publishing platform, which offers exclusive online access to 45 percent of their journals. While 1,500 institutions subscribe to BioOne Complete, a small but growing proportion of titles are open access, with 13 titles in 2015 of which only seven charged an APC. BioOne has a non-exclusive publishing agreement with the societies, which are free to enter into other publishing arrangements, with JSTOR for example, while the societies

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sell additional subscriptions (outside the BioOne collection) with a little more than half of the journals.

Despite the complexity of these arrangements, what BioOne brings to this study is (a) an example of a publishing organization in which libraries played a formative role and continue to constitute a sizable community of known dimensions, committed to subscribing to a set of journals in the biological sciences; (b) a demonstration of small societies' interest in entering into non-profit agreements that increase their journal distribution and income; a means of seeing how the proposed model applies to journals in the broader field of biology; and (c) a potential organizing body for coordinating scholarly society involvement in this model.

We assembled data on fourteen societies that belonged to BioOne in 2015 (accounting for 21 journals and 20 percent of the articles in BioOne). The societies had an average annual revenue of $1,539 per article, which includes a BioOne royalty payment (Table 11). The Florida Entomological Society is an exception on this list, as its *Florida Entomologist* is one of a dozen open access journals (publishing 642 articles in total) associated with BioOne in 2015. The open access titles pay BioOne for platform and other services rather than receive royalties. Two other of the societies on this list also have publishing partnerships with, in one case, Taylor and Francis and, the other, the University of Chicago Press; these partners' revenue, although unavailable to this study, will need to be factored into the expenses to be met by funder and library in a fully realized version of this model. Among the other societies, we were able to identify the revenue of five journals for which subscriptions were sold outside of BioOne; these journals averaged 363 subscribers, while generating $1,322 an article for their respective society (Table 12).

Table 11. Fourteen societies (21 journals) with BioOne with articles and revenue in 2015.

Scholarly Society	Articles published	Publishing revenue	Revenue/ article
American Assoc. of Avian Pathologists	86	$155,739	$1,811
American Association of Zoo Veterinarians	159	$187,015	$1,176
American Fisheries Soc. (5 titles)[a]	394	$867,995	$2,203
American Malacological Society[b]	15	$15,240	$1,016
American Society of Mammalogists (2 titles)	141	$150,000[c]	$1,064

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American Society of Parasitologists	142	$78,182	$551
Eagle Hill Institute (3 titles)	227	$306,246	$1,349
Florida Entomological Society[d]	163	$47,106	$289
National Association of Biology Teachers[b]	89	$234,084	$2,630
National Shellfisheries Association	103	$157,747	$1,532
Radiation Research Society	147	$407,953	$2,775
Society for Freshwater Science[d]	128	$178,649	$1,396
Society for the Study of Reproduction	280	$790,473	$2,823
Waterbirds Society[b]	52	$48,457	$932
	101/journal	$258,920	$1,539

[a] Does not include revenue of its publishing partner Taylor and Francis.
[b] Offered exclusively online with BioOne.
[c] 2014 is most recent year available for IRS 990 Form.
[d] Publishes an open access journal.
[e] Does not include revenue of its publishing partner University of Chicago Press.

Table 12. Five journals that sell subscriptions outside their BioOne membership for 2015.

Journal	*Biology of Reproduction*	*Journal of Parasitology*	*Journal of Shellfish Research*	*Journal of Zoo and Wildlife Medicine*	*Radiation Research*
Society	Society for the Study of Reproduction	American Society of Parasitologists	National Shellfisheries Association	American Association of Zoo Veterinarians	Radiation Research Society
Articles in 2015	280	142	103	159	147
Revenue (all sources)	$790,473	$78,182	$157,747	$187,015	$407,953
BioOne royalty[a]	$108,255	$54,901	$39,822	$61,473	$56,834
Subscription Revenue	$682,218	$23,281	$117,925	$125,542	$351,119
Sub. revenue/article	$2,365	$140	$1,121	$570	$2,413
Subscription Fee	$930[b]	$500[b]	$430	$260	$780[b]
Subscribers	734	60	232	483	450

[a] Royalty estimated on a per-article basis from total paid to societies for 2015.
[b] 2017 institutional subscription fees (rest are 2015).

The fourteen societies represented here were among the larger members of BioOne. They published an average of 101 articles per journal, compared to a BioOne average or 56 for 2015 and filed detailed tax forms (in contrast to those BioOne societies with lower revenue levels, such as the Kansas Entomological Society, or were located outside the U.S. such as the East African Natural History Society). Because only the larger societies made their revenue figures available, in calculating the average society revenue, we discounted the average of $1,539 per

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article among the larger societies by 25 percent to $1,154 (Table 13). This enabled us to calculate how much funders and libraries will need to pay for articles associated with BioOne (Table 14).

At the same time, the 14 societies for which we have figures exhibit considerable differences in their per-article revenue. This points to how the proposed model both *caters* to current differences in publisher revenue (as it has funders and libraries match current revenue figures as its starting point) and *exposes* the extent of those differences in per-article revenues. This could provide a basis for funders, libraries, and publishers to discuss differences in expenses and value in light of submission and rejection rates, editorial services, and publishing innovations. Ideally, such such discussions will be about the value of improving scholarly publishing standards for all journals as a warrant for any price increases in subscribing to open access.

Table 13. BioOne and society royalty and revenue levels for 2015.

	BioOne + societies
Journals	190
Articles	10,754
BioOne revenue	$10,675,768[a]
BioOne royalties to societies	$4,157,761
BioOne royalties/article	$410
BioOne's after-royalties revenue	$6,518,007
BioOne after-royalties revenue//article	$606
Society revenue/article[b]	$1,154
Total revenue/article	$1,760

[a] IRS Form 990, 2015, publication income.

[b] Includes BioOne royalties and other sources, discounted by 25 percent from amount reported in Table 11.

The 23 BioOne journals that were indexed in PubMed had similar levels of article sponsorship as the 167 journals that were not, although both sets had a somewhat lower level of sponsorship than the other journals in this study, with Wellcome Trust and HHMI sponsorship rare enough to warrant their omission in this case (Table 14).

Table 14. Distribution of sponsorship for BioOne PubMed and non-PubMed journals for 2015.

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	PubMed indexed	Not in PubMed	Total	Revenue share
Journals	23	167	190	190
Sponsored articles	2,437 (72%)	5,694 (77%)	8,132 (76%)	$14,387,563
Unsponsored articles	936 (28%)	1,687 (23%)	2,623 (24%)	$4,617,168
Articles published	3,373 (100%)	7,381 (100%)	10,755 (100%)	$18,931,004
Article sponsorships (*n* = 8,132)				
NIH	294 (11%)	42 (0.6%)	336 (4%)	$506,074
Other US gov't	412 (15%)	2,531 (37%)	2,943 (31%)	$4,429,773
Non-US gov't	2,082 (75%)	4,197 (62%)	6,279 (66%)	$9,451,716
Total	2,788 (100%)	6,770 (100%)	9,557 (100%)	$14,387,563

With the BioOne collection, the funders will cover 76 percent of the articles, paying $1,505 for each article for which they are credited, while the libraries will cover 24 percent of the articles, with each of the 1,500 libraries paying $3,078 to cover the costs of 2,623 unsponsored articles (Table 15).

Table 15. Projection of funder and library share of expenses for BioOne and its member societies for 2015.

	BioOne + societies
Funder article credits	9,557
Funders' share	$14,387,563 (76%)
Funder fee/article	$1,498
Unsponsored articles	2,623
Libraries' share	$4,617,168 (24%)
Individual library share	$3,078
Library fee/article	$1.17

Discussion

Under this funder-and library-pay open access model, current publisher revenues would be matched by a combination of funders and libraries, as demonstrated here with two biomedical publishers and one biology aggregator (Table 16). The publishing expenses for 84 percent of the articles will be distributed among the many funders supporting biomedical research, with each

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paying proportionately for the articles that credit their support. Among funders, the NIH would have much to gain in bioinformatics, in addition to advancing its long-time goal of universal open access. It could use its buying power to improve the publishers' provision of article metadata to PubMed and research data to other NCBI repositories. It could coordinate with publishers to improve the reporting standards for clinical trials on matters such as power calculations, primary outcomes, allocation concealment, and attrition [25]. The aim would be to increase indexing precision and data utility, while reducing the costs associated with manual intervention and supporting PubMed Central as an open access repository [26-27]. "Experience has shown," NIH currently advises publishers, "that this integration of information resources leads users to new knowledge and stimulates scientific discovery" [28].

Table 16. Funder and library share of open access publishing expenses for 2015.

	elife	PLOS	BioOne + Societies	Total/Average[a]
Journals	1	7	190	198
Total articles	956	31,655	10,755	43,366
Funder fee/article	$4,081	$1,189	$1,498	$1,329
Funder proportion	86%	86%	76%	84%
NIH share of all articles	33%	14%	3%	12%
Other US Gov't	2%	3%	23%	8%
HHMI	8%	0.4%	-	0.5%
Wellcome Trust	6%	2%	-	1%
Other non-US Gov't	37%	67%	50%	62%
Library proportion	14%	14%	24%	17%
Library fee/article	$3.80	$0.89	$1.17	$1.02
Library payment	$513	$3,961	$3,078	$7,552

[a] Weighted average

The libraries will pick up 17 percent of the articles overall, with each library paying $7,552 to cover the publishing costs of unsponsored articles in eLife, PLOS and BioOne in 2015. This is roughly five percent higher than the 2015 BioOne Collection subscription fee, which we estimate at $7,117. That is, subscribing to open access, when the majority of the articles are already open access, slightly increases costs for libraries. As the model is extended to other publishers, the vast majority of which employ a closed-subscription model, the effect of the

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funders' direct contribution to the publishers will reduce the libraries overall outlay, while increasing open access. As noted, however, funders may well decide to reduce their grants to researchers by the amount that they are paying publishers, which will lower the indirect-costs payments that make their way to the libraries [18]. The intent of this model, however, is not to create windfalls for libraries, nor has this prospect been the motivation, in our experience, behind library support for open access.

Under the current mixed model of biomedical research publishing represented by eLife, PLOS and BioOne, funders are underwriting publishing costs through a complex array of indirect forms and means involving with funder sponsorship, APCs and closed subscriptions (Fig. 1). The alternative model proposed here involves a more direct, accountable, and efficient means for funders and libraries to move journal publishing to universal open access (Fig. 2). While the biomedical field has attracted the highest levels of funding support, with 84 percent of articles sponsored by one or more funder, this model is applicable to other fields with proportionate reductions in funder participation and greater library coverage of costs.

Figure 1. The current mixed biomedical and biology publishing model, based on subscriptions, APC, and sponsorship, for eLife, PLOS, and BioOne for 2015.

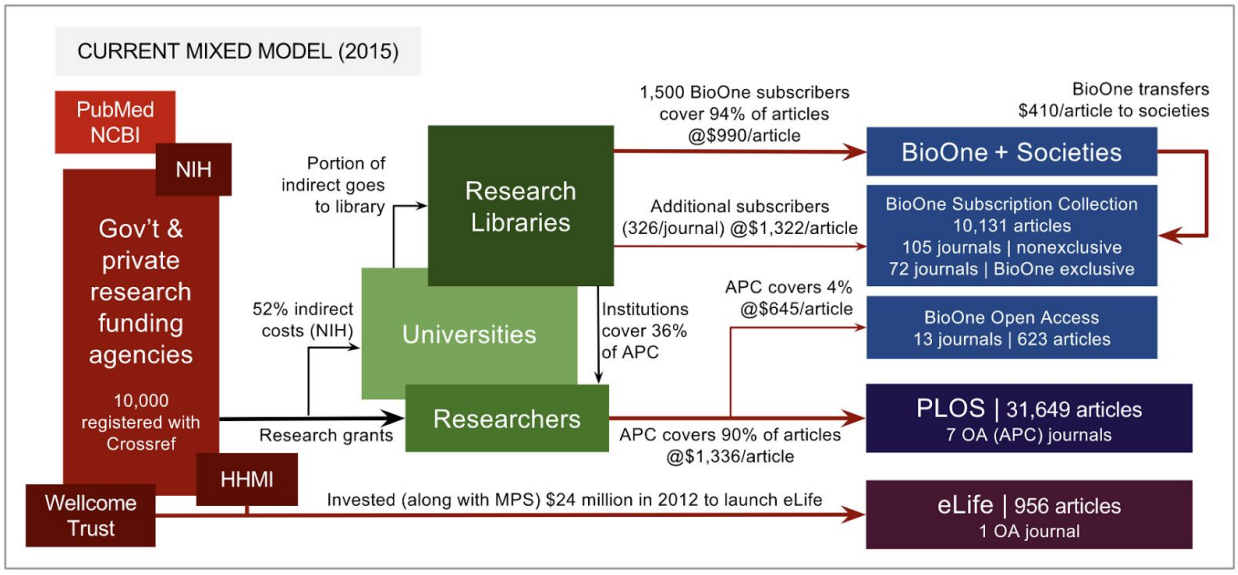

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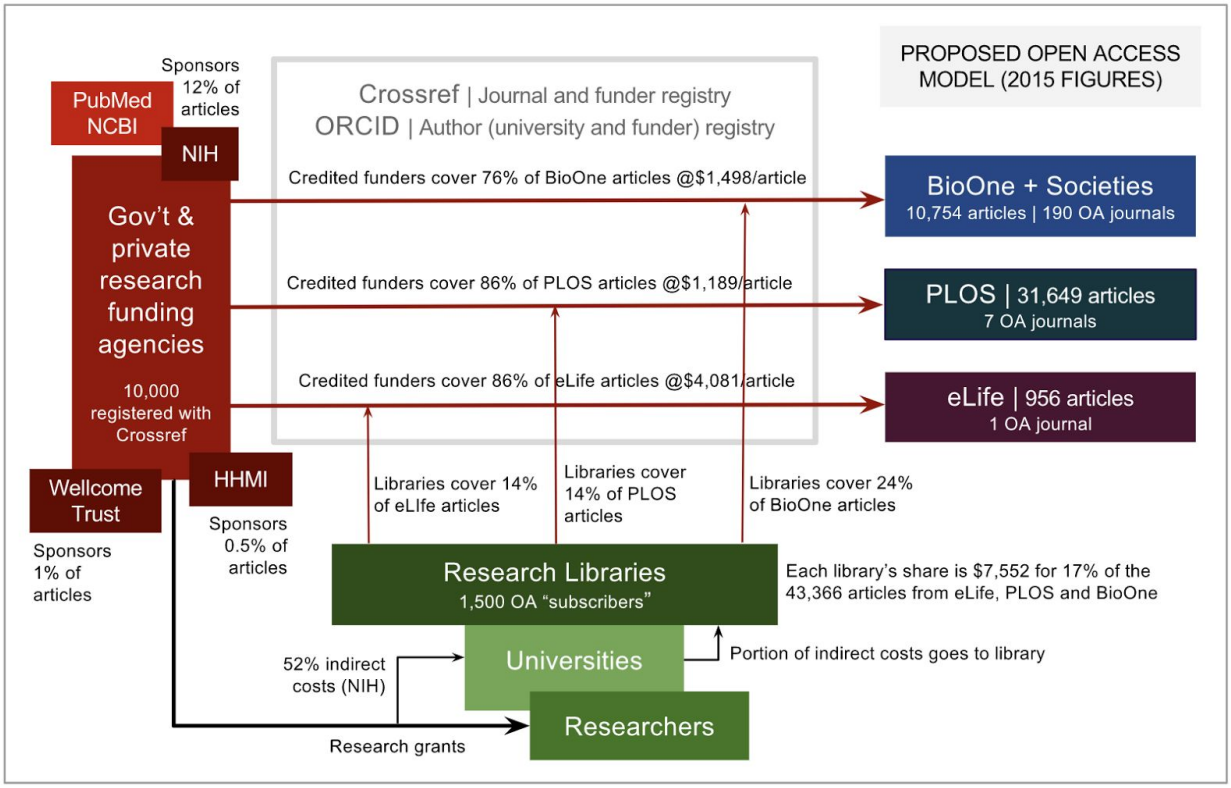
Fig. 2. Proposed biomedical and biology publishing model based on funder and library support for publishing expenses for eLife, PLOS, and BioOne for 2015.



As for how to initiate such a model, the Gates Foundation might be regarded as conducting a funder-side pilot study with the 24,000 journals that form part of its Chronos program, while SCOAP3 has demonstrated how twice the number of libraries considered in these calculations can agree to subscribe to open access for a set of journals. Still, the model, as outlined here, will require modifications to Crossref and ORCID systems. These initial transitions costs could well be supported by the foundations (such as Sloan, Arnold, Robert Wood Johnson, and Mellon) that have been underwriting just such open source and open access infrastructure development for scholarly communication. The goal of such modified systems will be to (a) provide more precise and detailed reporting for funders and indexing for researchers and the public; (b) achieve greater efficiency in publishing transaction costs after the initial transition costs of setting up automated systems; (c) ensure that publishers have the ability to innovate and improve editorial services (which has already been part of eLife's contribution both in methods and in open source tools); and (d) place a check on a history of monopolistic price increases in scholarly publishing [19].

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On this last point, while open access avoids the monopolistic elements of closed subscriptions, funders may still want to introduce spending caps on publisher expenses, much as SCOAP3 uses in its contracts with publishers, as well as provide incentives to authors and publishers for fair and transparent pricing [4, 20]. Introducing a form of centralized pricing will pose its own challenges, however, with much to be learned from the experience of the U.S. government's Medicare and Medicaid programs [21-23]. To take one example, this publishing model could pursue fair article costs by following Cramton and Katzman's "key features of a good auction design" for pricing which include "collaboration of government officials, industry representatives, and auction experts," while emphasizing "transparency, good price and assignment discovery, and strategic simplicity" in order to achieve "sustainable long-term competition among suppliers that reduces costs while maintaining high quality" [24].

Conclusion

Centuries before the 2001 World Social Forum in Porto Alegre adopted "another world is possible" as its motto, Descartes' asked his readers in *The World or Treatise on Light* to "allow your thought to wander beyond this world to view another world -- a wholly new one which I shall bring into being before your mind in imaginary spaces" [29]. The world that Descartes went on to describe was not really "another world" but a new perspective on the present one. Just so, what we have set out here may seem to be an imaginary world, while it is, in fact, building on an existing online publishing systems, journal and funder databases, and current funder involvement in scholarly publishing. It is the world that particle physicists have already created for their journals with library support; that research funders are building with new publishing processes and new relationships with publishers; and that publishers are embracing with their open access options. It is the world that this paper has attempted to demonstrate can be extended across the board of scholarly inquiry by further rationalizing and extending the open circulation of this public good. Open access is, after all, a concept to which funders and libraries already and wholeheartedly subscribe, but then so do the biggest of publishers [30].

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