UPDATED REPORT TO THE U.S. CONGRESS ON FINANCING MECHANISMS FOR OPEN ACCESS PUBLISHING OF FEDERALLY FUNDED RESEARCH

A Report by the

WHITE HOUSE OFFICE OF SCIENCE AND TECHNOLOGY POLICY

JUNE 2024

Contents

About this Report

The White House Office of Science and Technology Policy (OSTP) prepared this report to the Appropriations Committees of the Senate and the House in fulfillment of the requirement in the Joint Explanatory Statement (JES) accompanying Division C of the Consolidated Appropriations Act, 2024 (P.L. 118-42). The JES required OSTP to provide additional information with respect to financing mechanisms for open access publishing of federally funded research, as well as potential impacts of federal public access policies on peer review and research integrity.

About the Office of Science and Technology Policy

OSTP was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976 to provide the President and others within the Executive Office of the President with advice on the scientific, engineering, and technological aspects of the economy, national security, homeland security, health, foreign relations, the environment, and the technological recovery and use of resources, among other topics. OSTP leads interagency science and technology policy coordination efforts, assists the Office of Management and Budget with an annual review and analysis of federal research and development in budgets, and serves as a source of scientific and technological analysis and judgment for the President with respect to major policies, plans, and programs of the federal government. More information is available at http://www.whitehouse.gov/ostp.

Copyright Information

Suggested Citation

OSTP. (2024). Updated Report to the U.S. Congress on Financing Mechanisms for Open Access Publishing of Federally Funded Research. Office of Science and Technology Policy, Washington, DC, USA.

Note: Reference in this report to any product, service, enterprise, or individual, including any written works (i.e., books, articles, papers), is not an endorsement and does not imply official government sanction or endorsement of those entities or their views.

Executive Summary

The White House Office of Science and Technology Policy (OSTP) submits this report to the Appropriations Committees of the Senate and the House in fulfillment of the requirement in the Joint Explanatory Statement accompanying Division C of the Consolidated Appropriations Act, 2024 (P.L. 118-42).[1] This report details developments in the open access publishing landscape since November 2023, including potential and anticipated impacts of the August 25, 2022 Memorandum to Executive Departments and Agencies titled, "Ensuring Free, Immediate, and Equitable Access to Federally Funded Research" (2022 Memorandum)[2] on federal research investments, research integrity, and the peer review process. OSTP has discussed these impacts to the greatest extent possible in the broader context of the scholarly publishing landscape, which is a rapidly evolving global enterprise of which federally funded research is a vital part.

In its 2022 Memorandum, OSTP noted that: "Financial means and privileged access must never be the pre-requisites to realizing the benefits of federally funded research that the American public deserves." The goal of federal public access policies is therefore to ensure that federal investments unlock knowledge supported by American taxpayers so the benefits of federally supported research can benefit all of America. Through its implementation of the 2022 Memorandum, OSTP and its federal partners have continued to monitor global trends and developments in the scholarly communication landscape to ensure the health, vitality, diversity, and fairness of the research system.

This report follows OSTP's report in November 2023 (November 2023 Report),[3] which included an in-depth financial analysis of: (1) article processing charges (APCs) and transformative agreement costs borne by federal research grantees during fiscal years 2016 to 2021; (2) an assessment of these financing mechanisms on the volume of research publications authored by scientists from a variety of backgrounds and disciplines; and (3) a discussion of additional data needed to inform a more robust understanding of the financial impacts of public access policies for scholarly publications.[4] This current report elaborates on:

1. Implementation to advance federal public access policies. Updated agency public access policies will go into effect by December 31, 2025, in accordance with the 2022 Memorandum.

[1] As directed in P.L. 118-42, p. 438-439 (reporting requirement as incorporated by reference in the Joint Explanatory Statement accompanying Division C of the Consolidated Appropriations Act, 2024). Retrieved from https://www.govinfo.gov/content/pkg/CPRT-118HPRT55007/pdf/CPRT-118HPRT55007.pdf.

[2] OSTP. "Ensuring Free, Immediate, and Equitable Access to Federally Funded Research." The White House Office of Science and Technology Policy, August 25, 2022. https://www.whitehouse.gov/wp-content/uploads/2022/08/08-2022-OSTP-Public-access-Memo.pdf.

[3] OSTP. "Report to the U.S. Congress on Financing Mechanisms for Open Access Publishing of Federally Funded Research." The White House Office of Science and Technology Policy, November 22, 2023. https://www.whitehouse.gov/wp-content/uploads/2023/11/Open-Access-Publishing-of-Scientific-Research.pdf.

[4] The November 2023 Report was prepared as required by H.Rept. 117-395 (Committee Report to accompany Commerce, Justice, Science, and Related Agencies Appropriations Bill, 2023), p. 116 (as incorporated by reference in the Joint Explanatory Statement to accompany Division B of the Consolidated Appropriations Act, 2023). Retrieved from https://www.congress.gov/congressional-report/117th-congress/house-report/395/1

2. Trends in scholarly publishing since the release of the November 2023 Report, including further discussion of business models to enable public access to federally funded research, as well as domestic and global developments in advancing public access to research results.
3. An expansion of the analysis of estimated article processing charges paid to publish federally funded research from 2016 to 2022, with further discussion of limitations associated with calculating these charges.
4. Efforts to advance research integrity, including through implementation of federal public access policies and open science practices.
5. Continuing trends in peer review as they relate to research integrity, equity, and sustainability.

1. Continued Implementation and Coordination of U.S. Government Public Access Policies

The United States government has long-standing commitments to expanding access to the results of research that American taxpayers fund and to sustaining global leadership in research and development. These commitments are discussed in detail in both OSTP's August 2022 Economic Analysis of Federal Public Access Policy[5] and November 2023 Report to the Committees.[3] Progress towards advancing these goals is reflected in OSTP's previous reports to Congress with updates on the implementation status of the 2013 Memorandum to Agency Heads entitled "Increasing Access to the Results of Federally Funded Research" (2013 Memorandum).[6,7] These efforts have: supported the competitiveness of U.S. investigators, increasing the visibility, consumption, and potential impact of their work;[8] created opportunities for translation of federally funded research into patented technologies;[9,10] and broadened the reach of research results to diverse communities of readers.[11]

OSTP's primary mechanism for coordinating policies and programs that deliver on these commitments is through the National Science and Technology Council (NSTC) Subcommittee on Open Science, which

[5] OSTP. (2022). Economic Landscape of Federal Public Access Policy. The White House Office of Science and Technology Policy. Retrieved from https://www.whitehouse.gov/wp-content/uploads/2022/08/08-2022-OSTP-Public-Access-Congressional-Report.pdf

[6] OSTP. (2013, February 22). Increasing Access to the Results of Federally Funded Scientific Research. Retrieved from The White House Office of Science and Technology Policy: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/ostp_public_access_memo_2013.pdf

[7] See for example the 2021 OSTP Public Access Congressional Report: https://www.whitehouse.gov/wp-content/uploads/2022/02/2021-Public-Access-Congressional-Report_OSTP.pdf

[8] Piwowar, H., Priem, J., Larivière, V., Alperin, J. P., Matthias, L., Norlander, B., Farley, A., West, J., & Haustein, S. (2018). The state of OA: a large-scale analysis of the prevalence and impact of Open Access articles. *PeerJ*, *6*, e4375. https://doi.org/10.7717/peerj.4375

[9] Bryan, K., & Ozcan, Y. (2021). The Impact of Open Access Mandates on Invention. *The Review of Economics and Statistics*, *103*(5), 954–967. https://doi.org/10.1162/rest_a_00926

[10] Probst, B., Lohmann, P. M., Kontoleon, A., & Anadón, L. D. (2023). The impact of open access mandates on scientific research and technological development in the U.S. *IScience*, *26*(10), 107740. https://doi.org/10.1016/j.isci.2023.107740

[11] Huang, C.-K., Neylon, C., Montgomery, L., Hosking, R., Diprose, J. P., Handcock, R. N., & Wilson, K. (2024). Open access research outputs receive more diverse citations. *Scientometrics*, *129*. https://doi.org/10.1007/s11192-023-04894-0

includes membership of federal agencies and departments across the government.[12] Rechartered in August 2022, representatives of the Subcommittee have long been collaborating to develop and implement policies to increase access to federally funded research through several NSTC bodies, including the Task Force on Public Access to Scholarly Publications and the Interagency Working Group on Digital Data,[13] which were established or re-established pursuant to requirements in Section 103 of the America COMPETES Reauthorization Act of 2010,[14] as well as the Interagency Working Group on Open Science.[15]

Since the release of the 2022 OSTP Public Access Memorandum, OSTP has continued to work closely with federal agencies through the Subcommittee to establish and coordinate an implementation process for public access policy development, promoting alignment in policies across agencies where possible and enabling exchange of best practices. All covered agencies have submitted their plans for policy development to OSTP and the White House Office of Management and Budget (OMB). Plans have been reviewed and comments iteratively provided to agencies with opportunities to strengthen their plans and coordinate on policy development. While final policies are expected to be publicly posted by December 31, 2024 and go into effect by December 31, 2025, some agencies have already publicly posted their plans for policy development, both to socialize them across their research communities and to provide opportunities for stakeholder engagement and feedback. Agencies with publicly posted plans include the Administration for Community Living (ACL), the Agency for Healthcare Research and Quality, the Centers for Medicare and Medicaid Services, the U.S. Department of Agriculture (USDA), the U.S. Department of Education, the U.S. Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), the National Institute of Standards and Technology, the National Science Foundation (NSF), the National Institutes of Health (NIH), the Social Security Administration, the U.S. Census Bureau, and the U.S. Geological Survey.[16]

In addition, agencies have hosted listening sessions and issued formal requests for information to hear directly from their various research communities.[17] These engagements with various stakeholder

[12] See National Science and Technology Council Subcommittee on Open Science charter: https://www.whitehouse.gov/wp-content/uploads/2022/08/08-2022-SOS-NSTC-CHARTER.pdf

[13] National Science and Technology Council. "Interagency Public Access Coordination: A Report to Congress on the Coordination of Policies Related to the Dissemination and Long-Term Stewardship of the Results of Federally Funded Scientific Research." Executive Office of the President, March 2012. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/public_access-final.pdf.

[14] Public Law 111 - 358 - America COMPETES Reauthorization Act of 2010, 103 § (2011). https://www.govinfo.gov/app/details/PLAW-111publ358.

[15] See Interagency Working Group on Open Science charter: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/NSTC/cos-iwgos-charter-1016-signed.pdf

[16] OSTP has been coordinating with CENDI, an interagency working group of senior scientific and technical information managers, to update Science.gov with public access plans and policies, providing a central portal for stakeholders to access public access policy developments. See: https://www.science.gov/Public-Access-Plans-Guidance.html

[17] See, for example, USDA's Notice of Stakeholder Listening Sessions (https://www.nal.usda.gov/about-us/events/public-access), the U.S. Department of Transportation's RFI to inform its public access plan (https://www.federalregister.gov/documents/2023/03/28/2023-06373/increasing-public-access-to-the-results-of-usdot-funded-transportation-research), NSF's RFI on public access policy development focusing specifically on equity considerations (https://www.federalregister.gov/documents/2023/11/16/2023-25267/request-for-information-rfi-on-nsf-public-access-plan-20-ensuring-open-immediate-and-equitable), and a recording of NIH's listening session on its draft public access plan (https://osp.od.nih.gov/events/virtual-listening-session-on-the-nih-public-access-plan/).

communities have focused on gaining input around impacts of public access policies on approaches to research and scholarly communication, training and capacity development needs to promote compliance, considerations for enhancing equity through implementation, and strategies to continue monitoring trends in knowledge dissemination. These efforts complement one-on-one engagements OSTP and federal public access leads continue to have regularly with members of the community, including publishers, scholarly societies, research institutions, investigators, and library organizations.

The Subcommittee on Open Science has also facilitated cross-agency engagement opportunities to demonstrate interagency coordination and provide the research and scholarly communication communities a view into key synergies and differences in agency approaches to implementing public access policies. For example:

- NSF and the American Association for the Advancement of Sciences co-hosted a webinar in July 2023—"How can public access advance equity and learning?"—designed to solicit input and ideas on equity considerations associated with federal agencies' public access plans. Panelists included representatives from OSTP, DOE, NASA, NSF, and NIH, as well as representatives from the research and publishing communities.[18]
- NIH sponsored a National Academies workshop in November 2023, which resulted in a Proceedings of a Workshop-in-Brief report.[19] The workshop provided a venue for key stakeholders, including researchers, libraries, publishers, scientific societies, healthcare providers, and patients, to discuss how Department of Health and Human Services agencies, including NIH, ACL, the Administration for Children and Families, and the Food and Drug Administration, can work to ensure public access policies promote equitable outcomes for both producers and consumers of scientific knowledge.
- NASA funded a Higher Education Leadership Initiative for Open Scholarship (HELIOS) workshop hosted by Florida International University in January 2024, bringing together leaders in higher education to discuss pathways for incentivizing the practice of open science.[20] The workshop featured a session with public access leads from OSTP, DOE, NASA, NSF, and NIH to discuss the policy development and implementation process, as well as provide a forum for these leaders to share challenges and opportunities.[21]

Engagements like those highlighted in this section continue in parallel with agency efforts to develop their approved public access plans into policies for peer-reviewed scholarly publications and scientific data. Agency public access representatives also continue to meet twice monthly through an OSTP-convened community of practice to share input from their respective communities, best practices, and challenges and opportunities for policy implementation. Collectively, OSTP's approach to

[18] For the recording, presenter slides, speaker biographies, and other resources, see: https://www.aaas.org/events/how-can-public-access-advance-equity-and-learning

[19] See National Academies workshop on "Enhancing Public Access to the Results of Research Supported by the Department of Health and Human Services," which includes the Proceedings of a Workshop-in-Brief: https://www.nationalacademies.org/event/40741_11-2023_enhancing-public-access-to-the-results-of-research-supported-by-the-department-of-health-and-human-services-a-workshop

[20] The U.S. Government defines "open science" as "the principle and practice of making research products and processes available to all, while respecting diverse cultures, maintaining security and privacy, and fostering collaborations, reproducibility, and equity." See: https://open.science.gov/

[21] See NASA Leadership Workshop at Florida International University: https://www.heliosopen.org/nasa-fiu-helios-open-scholarship-leadership-workshop/event-two-gfhna

implementation and interagency coordination recognizes the complexity and evolution of the scholarly communication ecosystem. As a result, these efforts continue to prioritize working across and engaging the entire research and communication ecosystem to ensure the health, vitality, diversity, and fairness of the research system as the U.S. government advances its public access goals.

2. Continued Developments around Business Models Associated with Increasing Public Access to Peer-Reviewed Scholarly Publications

OSTP understands the Committees' interest in the evolution of scholarly publishing, particularly with respect to business models associated with increasing public access to peer-reviewed scholarly publications. As described in OSTP's November 2023 Report, OSTP and federal agencies draw distinctions between the terms "public access" and "open access." Public access refers to the free availability of federally funded scholarly materials to the public and is a policy term, whereas open access (OA) refers to a broad set of publication sharing principles and practices as adopted by the research and publishing communities. OA publishing generally refers to a publishing model whereby digital articles are made available to readers at no cost, in contrast to subscription or other models that require payment by readers to access and use content.

While the 2013 and 2022 OSTP Public Access Memoranda encourage agencies to provide free public access to federally funded scholarly publications, there are a number of OA business models to achieve this recommendation, as described in detail in Section 2 of the November 2023 Report.[3] These business models are often categorized by the *color system* outlined in Table 1; each color represents a different copyright, fee, payer, and access combination, allowing authors flexibility to choose how their research becomes openly accessible. Importantly, this report distinguishes between the publishing "fees" and "charges" levied on authors or institutions on the one hand and "costs" borne by publishers to deliver their services on the other.[22]

OA Model	Description	Associated Author Fees
Green OA	Refers to the author or a third party archiving the author-accepted manuscript (AAM)[23] by depositing the paper into a freely available public access repository, such as an agency-designated repository.	No fee.
Gold OA	Refers to the final version of record (VOR)[24] of an article published in a fully open access journal that makes all articles immediately, permanently, and freely available on the journal's website.	Author-facing article processing charges (APCs) may be charged.
Diamond OA	Diamond OA is considered a subset of Gold OA and may also be referred to as "Platinum OA." Refers to the publisher, or the publisher's sponsor, covering costs for production and for providing immediate and free access to the VOR.	No fee.

[22] Grossmann, A., & Brembs, B. (2021). Current market rates for scholarly publishing services. *F1000Research*, *10*, 20. https://doi.org/10.12688/f1000research.27468.2

[23] The author-accepted manuscript (AAM) is the author's final manuscript of a peer-reviewed paper as accepted for journal publication, including all modifications from the peer-review process.

[24] The version of record (VOR) is the publisher's authoritative copy of a paper, including all modifications from the publishing peer review process, copyediting, stylistic edits and formatting changes

OA Model	Description	Associated Author Fees
Bronze OA	Refers to the version of record being made temporarily available by the publisher, who can grant and remove access at any time without warning. Bronze OA publications may have limited or unclear reuse rights. Licensing also varies for Bronze OA publications; some have open licenses attached to them, others may not.	No fee, but not everyone considers this contingent arrangement to be OA.
Hybrid OA	Refers to articles that are published in a subscription journal, but whose version of record is nevertheless made freely available based on the author's payment of an APC to the publisher or journal.	APCs charged to the author.

Table 1. The color system describing models for providing OA to scholarly literature.

Recognizing that the scholarly communication ecosystem is highly complex and rapidly evolving, the U.S. government's approach to implementing public access policies for peer-reviewed publications is necessarily flexible, allowing for multiple routes towards achieving goals around free, immediate, and equitable access to research results. This rapid evolution is evidenced by a number of global developments in advancing different OA business models in the months since OSTP's November 2023 Report was released. To narrow in on those that may most directly influence federally funded researchers, OSTP first focused on changes in the business models of the top 100 journal titles in which federally funded research was published from 2016 to 2021, according to data from Clarivate's Web of Science.[25] The following developments are of note among this set of titles or their publishers:

- **Experimentation with new business models to enable free access to read and publish journal articles.** The Subscribe to Open (or S2O) model provides an alternative to pay-to-publish models for enabling free and immediate access to the final version of record of an article published in a journal.[26] This model uses subscription revenues to convert paywalled journals to full open access for one year at a time. If enough institutions subscribe to the journal for a given year, the articles for that year are free to access and authors are not charged an APC to publish; if the journal does not meet their subscription target for a given year, articles published in that year will be subscription access only on the journal's website, though authors may make their articles publicly accessible in an agency-designated repository through the Green OA route. Three of the top 100 journals—*Journal of Applied Physics* and *Physics of Plasma* (AIP Publishing)[27] and *Astronomy and Astrophysics* (EDP Sciences)[28]—hit their targets for 2024, enabling their published volumes to be OA for the year. In addition, the American Society for Microbiology announced in summer 2023 that it would be

[25] Publication data was retrieved from Web of Science in September 2023. OSTP collected all "Articles" and "Review Articles" published between 2016 and 2021, filtering the field for "Funding Organization" with federal funding agencies covered by the 2013 Memorandum. Notably, this analysis relies on accurate reporting of funding information. A more detailed discussion of caveats of this analysis, including results retrieved from other bibliographic platforms, such as Digital Science's Dimensions, Elsevier's Scopus, and Lens.org, are further detailed in Section 3.

[26] Crow, R., Gallagher, R., & Naim, K. (2019). Subscribe to Open: A practical approach for converting subscription journals to open access. *Learned Publishing*, *33*(2), 181–185. https://doi.org/10.1002/leap.1262

[27] See AIP announcement: https://publishing.aip.org/about/news/aip-publishing-launches-subscribe-to-open-pilot-in-two-flagship-journals/

[28] See EDP Sciences announcement: https://www.edpsciences.org/en/news-highlights/2979-astronomy-astrophysics-to-remain-in-open-access-under-subscribe-to-open-in-2024

converting their publishing model to S2O for their subscription journal titles in 2025, including the *Journal of Virology*, which is among the top 100 journals for federally funded research. [29]

- **Conversions from subscription to fully open access publishing models.** Only one of the top 100 journals—*Monthly Notices of the Royal Astronomical Society*—transitioned its publishing model from a subscription model that allowed for hybrid OA publishing to a fully open access journal.[30] No change was made to APCs to publish research papers for this title, though the journal has implemented a lower rate for publishing letters.
- **Increase in article processing charges for both fully open and hybrid journals.** In the November 2023 Report, OSTP noted that APCs for both hybrid and fully open journals have risen over the years. An analysis of the four largest fully OA publishers found that the rate of APC increases outpaced that of inflation between 2012 and 2018.[51] To understand whether and how APC rates have risen in the last year, OSTP retrieved APCs for the top 100 journals for federally funded research from 2016 to 2021 and compared APC rates retrieved from May 2024 to those retrieved from August 2023, which were used in OSTP's 2023 report (Figure 1). The average APC for fully open journals rose from $2,995.02 in 2023 to $3,024.96 in 2024 (a 1.00% increase); the average APC for hybrid journals rose from $3,999.23 in 2023 to $4,072.14 in 2024 (a 1.82% increase). Both increases are below the economy-wide inflation rate over that time period. OSTP and its agency partners will continue to monitor these trends.

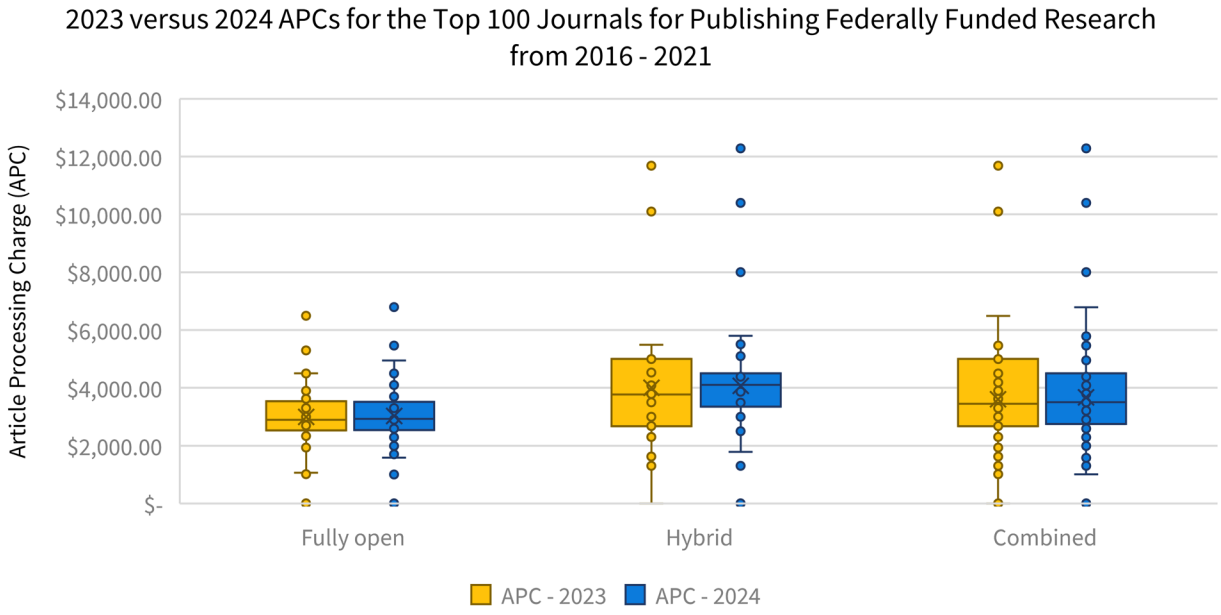

Figure 1. Comparison of the distribution of APC rates between 2023 and 2024 for the top 100 journals for federally funded research from 2016-2021.[25] Journals were separated by fully open and hybrid journals. APCs shown for 2023 were retrieved in August 2023 (used in OSTP's November 2023 Report) and APCs for 2024 were retrieved in May 2024. These rates are likely higher than those charged from 2016-2021.

[29] See ASM Communications announcement: https://asm.org/press-releases/2023/june/asm-publishing-moves-toward-open-access-model-unde

[30] See MNRAS announcement: https://academic.oup.com/mnras/pages/mnras-open-access

- **Emergence of the "Article Development Charge."** In October 2023, the American Chemical Society (ACS), which publishes 17 of the top 100 journal titles for federally funded research, enacted a new zero-embargo OA option called an "article development charge" (ADC).[31] The ADC is a $2,500 fee that is applied to manuscripts that are sent out for peer review. Payment of the ADC *does not guarantee* an article will be accepted for publishing. If a researcher who paid the ADC has their article accepted, they can then deposit the author-accepted manuscript into an agency-designated public access repository.

In addition to the above developments in the top 100 journal titles for publishing federally funded research from 2016 – 2021, the scholarly publishing landscape has seen additional notable trends and shifts since November 2023:

- **Experimentation with advancing sustainable Diamond Open Access in the United States.** OSTP discussed the growing interest in the Diamond OA model, also called Platinum OA, in its 2023 Report. Diamond OA is a model in which articles are free to read and publish. Rather than drawing on subscription revenue to recoup the costs of publishing or APCs to provide free access, Diamond OA efforts may draw on a variety of different revenue streams to fund production costs.[32] A 2021 survey of the global Diamond OA publishing landscape found that financial support is drawn from a variety of sources, including institutional support from research performing organizations, grants from government and national research funders, publishers, and scholarly societies.[33] The report also noted a reliance on voluntary labor and in-kind support by research institutions. While interest in Diamond OA has grown in the United States, there are long-standing, successful Diamond OA efforts in Central and South America, including the publicly-supported Scientific Electronic Library Online (SciELo) and the Network of Scientific Journals from the Latin American and Caribbean Region, Spain, and Portugal (Redalyc), as well as in Canada through Coalition Publica focusing on the Humanities & Social Sciences and Arts & Letters. In October 2023, global leaders in scholarly communication gathered for the Global Summit on Diamond Open Access, which focused on five key elements: infrastructure, policy development, governance, research evaluation and recognition, and sustainability.[34] In addition to advancing various global commitments to promote Diamond OA, the summit sparked discussions among members of the scholarly communication community in the United States. In April 2024, the Big Ten Academic Libraries, California Digital Library, and Lyrasis announced their "Better Together" collaboration, committing to pool their existing efforts and combine their strengths to develop a strengthened, sustainable, and equitable

[31] See ACS announcement: https://www.acs.org/pressroom/newsreleases/2023/september/acs-publications-provides-new-option-to-support-zero-embargo-green-open-access.html

[32] Izabella Penier, Martin Paul Eve, and Tom Grady. "COPIM - Revenue Models for Open Access Monographs 2020," September 7, 2020. https://doi.org/10.5281/zenodo.4011836. (Note: while this report describes models for monographs, the revenue models are also used to finance OA publishing of journal articles)

[33] Becerril, A., Bjørnshauge, L., Bosman, J., Frantsvåg, J. E., Kramer, B., Langlais, P.-C., Mounier, P., Proudman, V., Redhead, C., & Torny, D. (2021). The OA Diamond Journals Study. Part 2: Recommendations. In *munin.uit.no*. https://doi.org/10.5281/zenodo.4562790

[34] Saenen, B., Ancion, Z., Borrell-Damián, L., Mounier, P., Oliva Uribe, D., Papp-Le Roy, N., & Rooryck, J. (2024). *2nd Diamond Access Conference Report*. Science Europe. https://doi.org/10.5281/zenodo.10684544

framework for Diamond OA in the United States and North America.[35] Their efforts are now focused on assessing the landscape of Diamond OA publishing in the United States, convening and coordinating across members of the Diamond OA community, and building capacity for Diamond OA centers. Other efforts to advance Diamond OA in the United States continue. For example, the MIT Press was awarded an NSF Early-Concept Grant for Exploratory Research (EAGER) award to expand their shift+OPEN initiative to flip subscription-based journals to Diamond OA.[36]

- **Continued growth of transformative agreements in the United States.** Section 5 of OSTP's November 2023 Report included a discussion of the rise of transformative agreements (TAs), which are negotiated between institutions or consortia and publishers. "Transformative agreements" are an umbrella term that encompass a range of contracts that may include traditional subscription licenses and APC discounts, or waivers that may cover a certain number of articles that may be published in hybrid or fully open journals.[37] Figure 2 illustrates updated data from the Efficiency and Standards for Article Charges (ESAC) Initiative's Market Watch.[38] OSTP has also observed partnerships across consortia to enter into TAs. For example, in January 2024, California Digital Libraries, which represents the 10-campus University of California system, and 48 private and public research and academic institutions represented by the Statewide California Electronic Library Consortium (SCELC) entered into a three-year agreement with Wiley.[39] The TA builds on the success of CDL and SCELC's 2022 TA with the American Chemical Society, the first California-wide agreement, making even more research eligible for OA publication in the region.[40] Of the covered institutions, 24 are Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (HSIs), or Asian American and Native American Pacific Islander Serving Institutions.

[35] Waibel, G., Wilkin, J., & York, M. (2024, April 18). *Better together: BTAA Libraries, CDL and Lyrasis commit to strengthen Diamond Open Access in the United States*. Library Technology Guides. https://librarytechnology.org/pr/29989/better-together-btaa-libraries-cdl-and-lyrasis-commit-to-strengthen-diamond-open-access-in-the-united-states

[36] See shift+OPEN: http://mitpress.mit.edu/shiftOPEN/

[37] Borrego, Á., Anglada, L., & Abadal, E. (2020). Transformative agreements: Do they pave the way to open access? *Learned Publishing*, *34*(2), 216–232. https://doi.org/10.1002/leap.1347

[38] Note that OSTP did not extend this analysis to 2024. While many libraries, consortia, and research institutions negotiating TAs register information related to those agreements in the ESAC registry, it is not a complete up-to-date accounting of these agreements and there may be lags between when institutions enter into an agreement and when they report it in ESAC. For example, the 2024 TA between Wiley, CDL, and SCELC is not yet registered.

[39] See press release: https://osc.universityofcalifornia.edu/2024/01/california-universities-partner-with-wiley-on-landmark-open-access-agreement/

[40] See press release: https://osc.universityofcalifornia.edu/2022/05/uc-csu-scelc-acs-new-transformative-agreement/

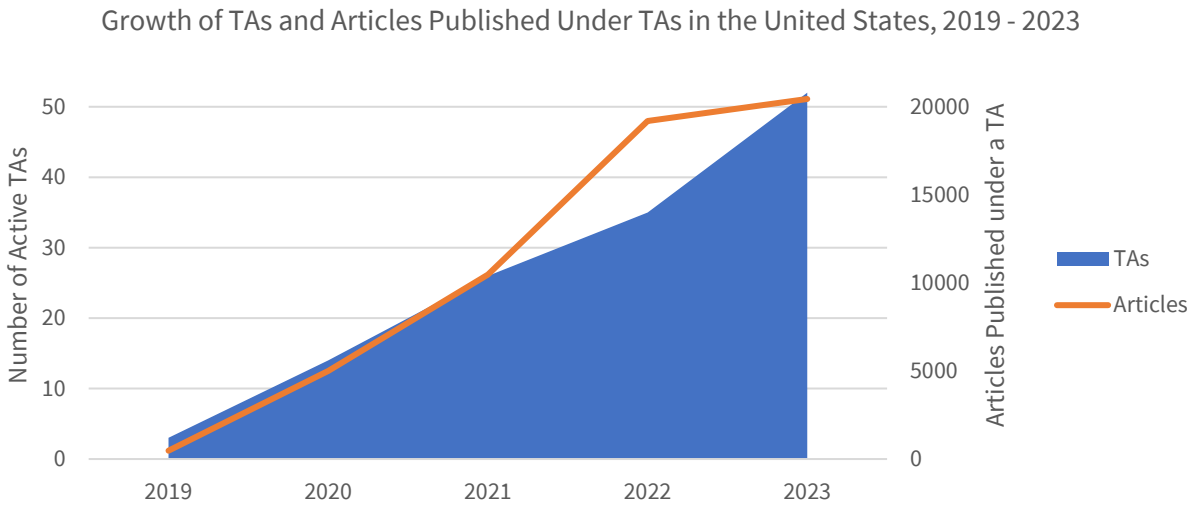

Figure 2. The growth of transformative agreements (represented by the solid blue fill) and articles published under transformative agreements (represented by the orange line) in the United States between 2019 and 2023. Data were retrieved from Efficiency and Standards for Article Charges (ESAC) Initiative's Market Watch in May 2024.[41] Articles represented in this figure are not necessarily articles resulting from federal support.

- **Continued growth and adoption of preprint publications.** A preprint is a version of a scientific paper that is publicly posted at no cost to the author and free to read before formal peer review. While the 2022 Memorandum focuses on increasing public access to peer-reviewed scholarly publications, OSTP has observed a continued growth and adoption of preprints as a form of scholarly communication. OSTP discussed trends in preprint publishing in its November 2023 Report, including disciplinary specific trends, efforts around preprint peer review, and findings from Phase 1 of the NIH Preprint Pilot.[3,42] The Pilot, now in Phase 2, is continuing to explore approaches to increase the discoverability of early NIH research results posted to eligible preprint servers by making NIH-supported preprints available in PubMed Central (PMC) and PubMed.[43] As of May 2024, over 24 thousand preprint records citing NIH funding support and posted to an eligible preprint server after January 1, 2023 have been added to PMC. There have also been proposals by members of the scholarly communication community to leverage the growing adoption of preprints by having journal editors identify articles of interest posted on preprints servers and invite authors to submit their preprints for peer review and potential journal publication.[44,45] It is now common practice for journals to accept articles for review that have been published as preprints, recognizing that preprints are becoming a popular mechanism for researchers to share their results early, gain

[41] See ESAC Market Watch: https://esac-initiative.org/market-watch/
[42] Funk, K., Zayas-Cabán, T., & Beck, J. (2022, December 13). Phase 1 of the NIH Preprint Pilot: Testing the viability of making preprints discoverable in PubMed Central and PubMed. *bioRxiv* [Preprint]. https://doi.org10.1101/2022.12.12.520156
[43] For more information about the NIH Preprint Pilot: https://www.ncbi.nlm.nih.gov/pmc/about/nihpreprints/
[44] Green, T. (2019). Is open access affordable? Why current models do not work and why we need internet-era transformation of scholarly communications. *Learned Publishing*, *32*(1), 13–25. https://doi.org/10.1002/leap.1219
[45] Barsh, G. S., Bergman, C. M., Brown, C. D., Singh, N. D., & Copenhaver, G. P. (2016). Bringing PLOS Genetics Editors to Preprint Servers. *PLOS Genetics*, *12*(12), e1006448. https://doi.org/10.1371/journal.pgen.1006448

community feedback and visibility, and contribute to open science.[46] Surveys have found that researchers in the United States and Europe are leading adoption of preprints, reporting a higher familiarity with preprinting and a stronger commitment to its benefits.[47] Private funders have also begun strongly encouraging or mandating awardees publish their manuscripts first as preprints.[48]

3. Estimated OA Fees Paid by Federally Funded Researchers from 2016 to 2022 and Impacts on Federal Research Investments

OSTP's November 2023 Report to the Committees outlined key limitations to calculating OA fees in Sections 4 and 5 and the additional data needs for more accurate and detailed analyses.[3] In the months between November 2023 and the development of this current report, these data needs have not been met. Nevertheless, OSTP has endeavored to extend its original analysis to cover estimated fees incurred in 2022, while further illustrating the complexity of arriving at such calculations. To reiterate some of the largest barriers discussed in the November 2023 Report:

- **True APC expenditure records rest with the authors or institutions that pay these fees and the publishers that invoice them.** APCs paid by authors or institutions are not necessarily those listed on publicly available price lists. Those fees may be offset in a number of ways including through discounts and waivers provided by journals, as well as through transformative agreements negotiated by institutions or consortia. True APC records are neither publicly reported by publishers nor systematically reported to funders by researchers or their institutions.
- **Lack of data on how individual APCs were financed from federal grants versus other sources.** Open access fees—as well as other fees associated with publishing, including page charges—to publish scholarly literature come from many different sources, including individual researchers, libraries, and other institutional funds. Further, these fees are not centrally reported to funders. This lack of clarity on funding sources to cover APCs makes it difficult to estimate the percentage of federal research and development expenditures that go towards APCs. Given researchers use funds from other sources, OSTP's estimates of federal funds that finance APCs are likely overestimates.
- **Lack of clarity around how production costs associated with publication relate to APCs.** While some publishers have taken steps to implement pricing transparency frameworks,[49] there remains limited public information on per-article publication costs, such as those associated with content acquisition, peer review, production, and dissemination, on the revenues collected by the publishing industry, and on how such factors affect APCs. Most publishers consider these data to be proprietary information. Publishers that hold a number of journal titles are also able to employ

[46] Smart, P. (2022). The evolution, benefits, and challenges of preprints and their interaction with journals. *Science Editing*, *9*(1), 79–84. https://doi.org/10.6087/kcse.269

[47] Grossmann, A., & Brembs, B. (2021). Current market rates for scholarly publishing services. *F1000Research*, *10*, 20. https://doi.org/10.12688/f1000research.27468.2

[48] See, for example, funder policies like the Bill & Melinda Gates Foundation (https://gatesfoundationoa.zendesk.com/hc/en-us/categories/24807336892948-Open-Access-Policy-Refresh-2025), the Michael J. Fox Foundation (https://www.michaeljfox.org/news/new-mjff-policy-research-grantees-embraces-openaccess-movement), and the Wellcome Trust (https://wellcome.org/grant-funding/guidance/open-access-guidance/open-access-policy).

[49] Wise, A., & Estelle, L. (2020). Plan S Price Transparency Framework: Implementation Guide. In *Information Power*. https://www.informationpower.co.uk/the-plan-s-price-transparency-framework-implementation-guide

"cascading" or "transfer" systems for submission and review, further complicating the calculation of per-article production costs.[50] This lack of transparency in the relationship between APCs and production costs makes it difficult to project whether and how APCs may increase or decrease over time.

- **Continued evolution of business models and strategies for making publications publicly accessible.** As described in Section 2 of this report and throughout OSTP's November 2023 Report, there continues to be a great deal of evolution in scholarly communication to develop and advance sustainable approaches for increasing public access to research. Such a dynamic landscape does not lend itself well to predictions or projections around dominant models for public and open access to the scholarly literature. Once again, OSTP and its agency partners remain committed to author choice and flexibility of options to comply with public access policies.

To arrive at an updated estimate of APC expenditures between 2016 and 2022, OSTP asked the following questions: (1) What is the average APC fee for hybrid and fully open access journals in which federally funded researchers publish? (2) How many articles were published with federal funding support between 2016 and 2022, and through what open access financing mechanism (e.g., Green, Gold, Hybrid, Bronze), which have different charges associated with them? (3) Based on these estimates, what is the maximum amount that federally funded researchers may have spent to publish in these years?

Importantly, implementation of the 2022 Memorandum *does not require* expense on the part of a researcher; the researcher can comply with the policy by depositing their author-accepted manuscript in an agency-designated repository, also known as the Green OA route (Table 1). Should researchers choose to publish in a journal that requires APCs for immediate open access, the 2022 Memorandum allows researchers to include publication and data sharing expenses in their research budget proposals to federal agency sponsors of their research.

To extend the analysis in the November 2023 Report, OSTP used APCs displayed in Figure 1 for hybrid and fully open access journals. OSTP used the average charges retrieved in August 2023 for the top 100 journals for publishing federally funded research from 2016 to 2022, noting that 2023 rates are likely higher than those charged from 2016 to 2022.[51,52] The next step was to estimate the number of articles published with federal support. OSTP drew once again on data underlying a 2023 analysis of U.S. federally funded publications from 2017 to 2021, as well as additional analysis undertaken by its author in the months following publication using the bibliographic database and analytical tool Digital

[50] Under a "cascading" or "transfer" system for submission and review, if a submitted paper is rejected by the original journal, the publisher may offer to send it for consideration to a different journal owned by the same publisher. If the original submission was rejected after peer review, reviews may be bundled, so the article may not need to undergo another round of review, expediting the time to publication and negating additional costs for peer review.

[51] Khoo, S. Y.-S. (2019). Article Processing Charge Hyperinflation and Price Insensitivity: An Open Access Sequel to the Serials Crisis. *LIBER Quarterly: The Journal of the Association of European Research Libraries*, *29*(1), 1–18. https://doi.org/10.18352/lq.10280

[52] These estimates reflect the maximum total charges, and do not account for discounts and waivers provided by publishers, APC discounts resulting from transformative agreements, or lower charges for certain article or review types. In addition, some journals, such as those published by the American Astronomical Society (AAS), charge different rates based on the length of the article (OSTP assumed an average article length of 10 pages). Others charge different rates based on the embargo period and licensing. To avoid underestimating the total APCs associated with publishing federally funded research, OSTP used the highest possible APC charged by a publisher.

Science's Dimensions.[53,54] OSTP re-performed its complementary analysis using a different bibliographic database—Clarivate's Web of Science platform—retrieving articles published between 2016 and 2022 by OA status that note funding support from those agencies covered under the 2013 Memorandum.[55] In re-performing this analysis, OSTP noticed some discrepancies in article counts by OA status, not only in more recent years, which one might expect due to publication embargoes, but also dating back to publications from 2016. There are a number of reasons for this discrepancy, which highlight additional complexities of deriving estimates around the number of federally funded publications and APCs associated with those publications. These reasons may result in discrepancies when using the same bibliographic platform at two different points in time or when using different bibliographic platforms to perform the same analysis at a given point in time. They include:

- **Changes to journals indexed by bibliographic platforms.** Bibliographic platforms do not index across all of the published literature; rather, they selectively index across a subset of journals, books, and conference proceedings, based on inclusion criteria they develop. This subset varies from one bibliographic platform to the next and may change over time within a given bibliographic platform due to a variety of factors, including changes to inclusion criteria and the creation or dissolution of new journals over time.
- **Changes to how bibliographic platforms interpret data on funding sources.** Bibliographic platforms rely on accurate reporting of funding information, which is self-reported by authors and supplied by publishers. There is great variability in how funding sources are reported (or not reported), which affects the counts of publications resulting from federal support. In addition, different bibliographic tools and databases may have different sources of funding information and metadata due to differences in their methods for collecting such information.[56]
- **Changes to OA status of a particular article.** Several platforms rely on data from Unpaywall, which uses data from open indexes like Crossref and the Directory of Open Access Journals (DOAJ), as well as monitoring content from online article hosting locations, to find OA content. Platforms may supplement Unpaywall data with data from the DOAJ, which is a directory of journals that meet certain inclusion criteria,[57] as well as data about an article's license. Bibliographic platforms have integrated this OA directory service to provide the current OA status of a given publication at the time of analysis. Embargoes and delayed OA options can result in altered counts of Green, Gold, and Hybrid OA articles that were published more recently depending on when the analysis is run. In addition, Bronze OA articles, which are made free to read on a publisher's website without an explicit open content license, may be made subscription-only access at any point in time.[8]

[53] Schares, E. (2023). Impact of the 2022 OSTP Memo: A Bibliometric Analysis of U.S. Federally Funded Publications, 2017–2021. *Quantitative Science Studies*, *4*(1), 1–24. https://doi.org/10.1162/qss_a_00237

[54] Schares, E. (2023). *OSTP Impact*. Retrieved from https://github.com/eschares/OSTP_impact/tree/main

[55] Publication data was retrieved from Web of Science in September 2023. OSTP collected all "Articles" and "Review Articles" published between 2016 and 2021, filtering the field for "Funding Organization" with federal funding agencies covered by the 2013 Memorandum.

[56] For example, Web of Science supplements funding information provided through structured metadata from publication data sources like Crossref and PubMed with text-mining of the "Acknowledgments" and "Funding" sections. [See: Gibson, D., van Honk, J., & Calero-Medina, C. (2022, December 1). *Acknowledging the Difficulties: A Case Study of a Funding Text*. Leiden Madtrics. https://www.leidenmadtrics.nl/articles/acknowledging-the-difficulties-a-case-study-of-a-funding-text]

[57] See: https://doaj.org/apply/guide/

Bibliographic platforms also have different approaches to parsing Unpaywall data, particularly because Gold, Hybrid, Bronze, and Green OA models are not mutually exclusive. For example, an article published in a fully open access journal (i.e., Gold OA) may also have an author-accepted manuscript that was made available in a public access repository (i.e., Green OA). This may result in double counts of articles as both Green and Gold OA on some platforms.[58] Others disambiguate OA types by deferring to the "best OA location" determined by Unpaywall, which prioritizes publisher-hosted content (i.e., the version of record[24]) so there is no double-counting.[59]

To demonstrate variations in estimates of articles published with federal funding support from 2016 to 2022, OSTP extended its analysis using Elsevier's Scopus platform and Lens.org as a point of comparison to results retrieved by Digital Science's Dimensions and Clarivate's Web of Science. Figure 3 illustrates the variations in results by OA status. In addition, the number of articles retrieved varied by bibliographic platform, likely owing to the number of journals or data sources each index.

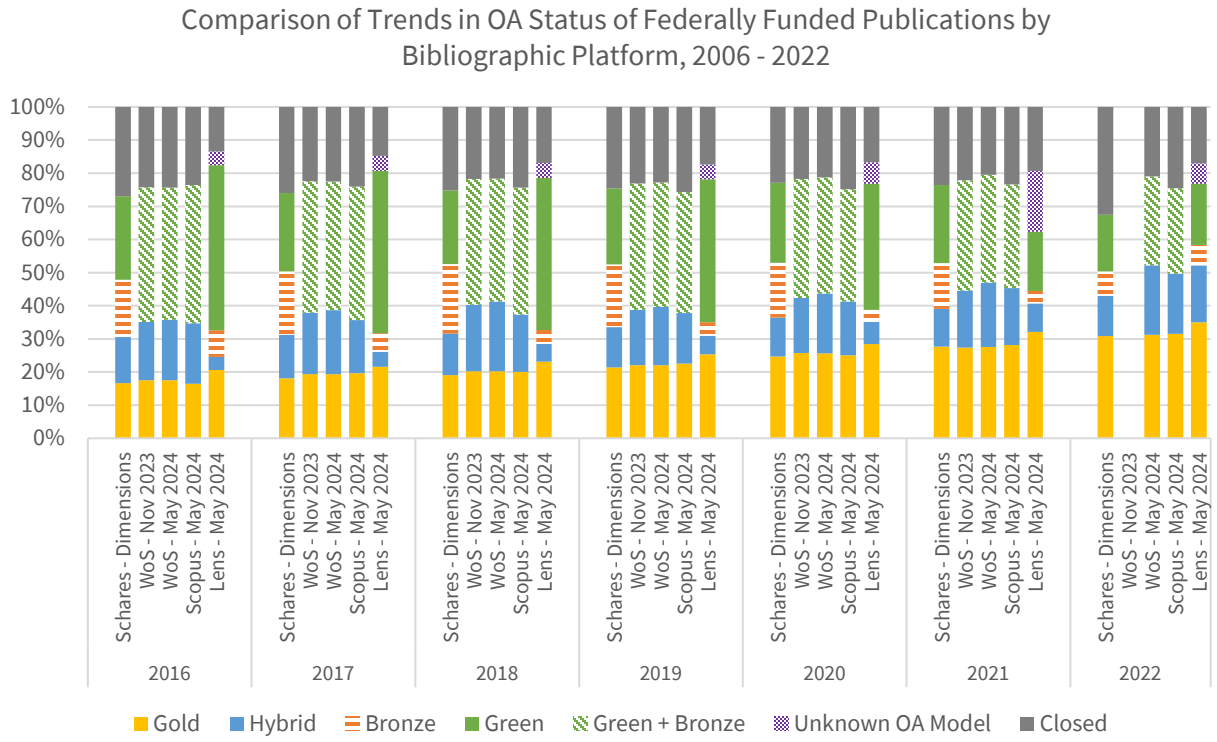

Figure 3. The proportion of federally funded research made publicly accessible through various OA models from 2016 to 2022.[60]

[58] In instances where OSTP found evidence of double counting of OA types, OSTP took the total number of articles coded as OA and subtracted the number of Gold and Hybrid OA articles to arrive at a combined count of Green and Bronze OA articles, which would have no APCs associated with them. Gold and Hybrid OA articles are mutually exclusive and are not double counted because Gold OA articles are published in fully open access journals (as identified by the DOAJ) and Hybrid OA articles are published in subscription-only journals that offer an APC option.

[59] See: https://support.unpaywall.org/support/solutions/articles/44001943223-how-is-the-best-oa-location-determined-

[60] Note that Lens.org has a subset of OA publications that they code as an unknown OA model because the license information is either unavailable or does not exist. See: https://support.lens.org/knowledge-base/open-access/

Finally, using various estimates of the number of federally funded research articles by OA status from 2016 to 2022, OSTP estimated total APC charges borne by federal grantees and researchers in this period using the mean APCs associated with hybrid and fully open journals from Figure 1. Unsurprisingly, discrepancies in the number of articles retrieved by each bibliographic platform resulted in a high degree of variability in estimated of APC expenditures (Figure 4 and Table 2).

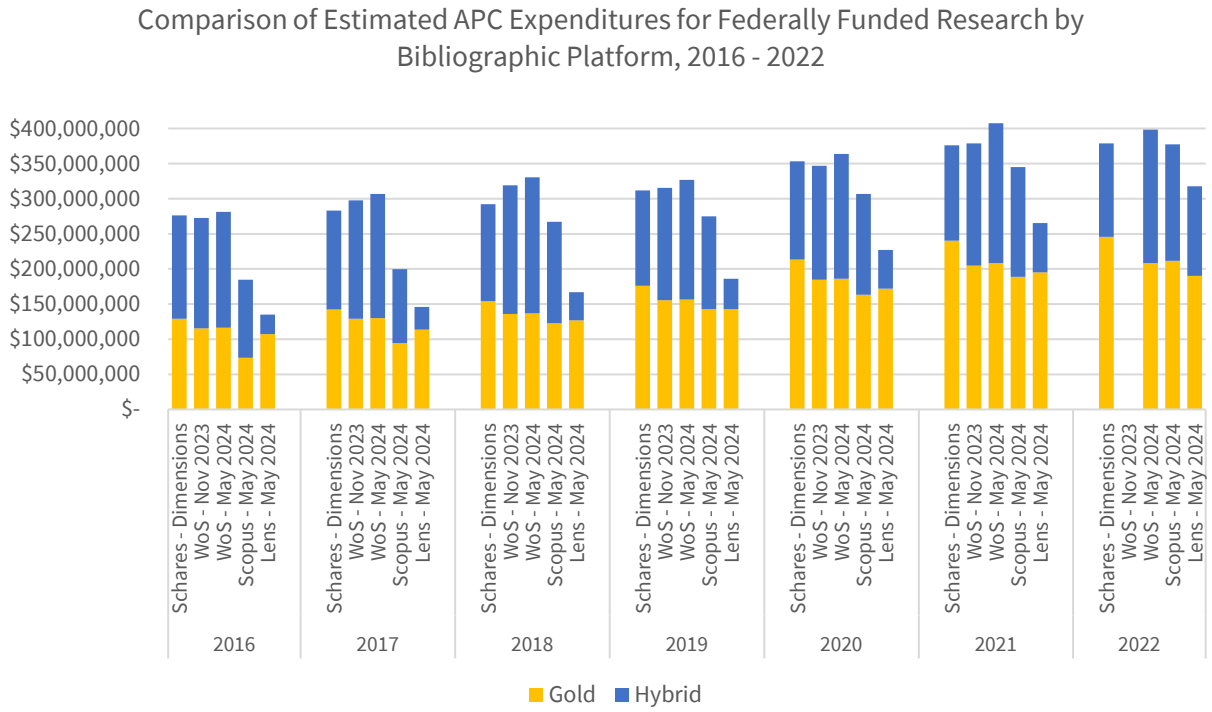

Figure 4. Estimated APC expenditures for scholarly publications resulting from federally funded research Estimates were calculated based on mean APC values for fully open and hybrid journals based on August 2023 APC rates. Articles published through other OA routes, such as Green and Bronze, incur no APCs.

Year	Total – Schares	Total – OSTP – WoS 2023	Total – OSTP – WoS - 2024	Total – OSTP – Scopus - 2024	Total — OSTP – Lens 2024
2016	$276,428,411.11	$272,484,574.03	$281,083,511.29	$184,577,348.37	$135,009,213.29
2017	$283,023,409.19	$297,539,227.27	$306,915,205.77	$199,652,457.15	$145,917,004.92
2018	$292,286,540.98	$319,157,142.11	$330,570,917.26	$267,192,062.91	$167,078,060.79
2019	$311,712,898.39	$315,220,487.16	$326,696,246.68	$275,063,595.16	$185,802,271.11
2020	$353,185,393.53	$347,030,687.95	$363,534,820.81	$306,917,141.22	$227,026,175.12
2021	$376,189,957.04	$378,661,260.31	$407,507,362.51	$345,201,206.50	$265,197,417.42
2022	$378,900,216.57	n/a	$398,516,458.66	$377,353,471.82	$317,879,025.24

Table 2. Estimate of annual expenditures on APCs, calculated based on the mean 2023 APC rate (Figure 1) and data from OSTP's analyses using different bibliographic tools compared to data from Schares 2023 on volume of federally funded publications by OA status from 2016 to 2022.

To understand the proportion of federal research and development expenditures that go towards APC fees, recognizing the previously discussed caveats associated with OSTP's estimates, OSTP compared the charges tabulated in Table 2 with total federal research and development budgets from FY2016 -

2022 (Figure 5).[61] Estimated APC expenditures averaged less than quarter of a percent for this time period (between 0.09 to 0.25 percent) depending on the bibliographic source used. OSTP does note that the percentage of individual grant awards or project budgets that go towards APCs likely varies significantly based on a variety of factors outlined in the November 2023 Report. These include disciplinary differences around funding and publishing outlined in Sections 4.1 and 6.4, as well as limitations in available data around true APC expenditures, which have been discussed in this section as well as throughout the November 2023 Report.[3]

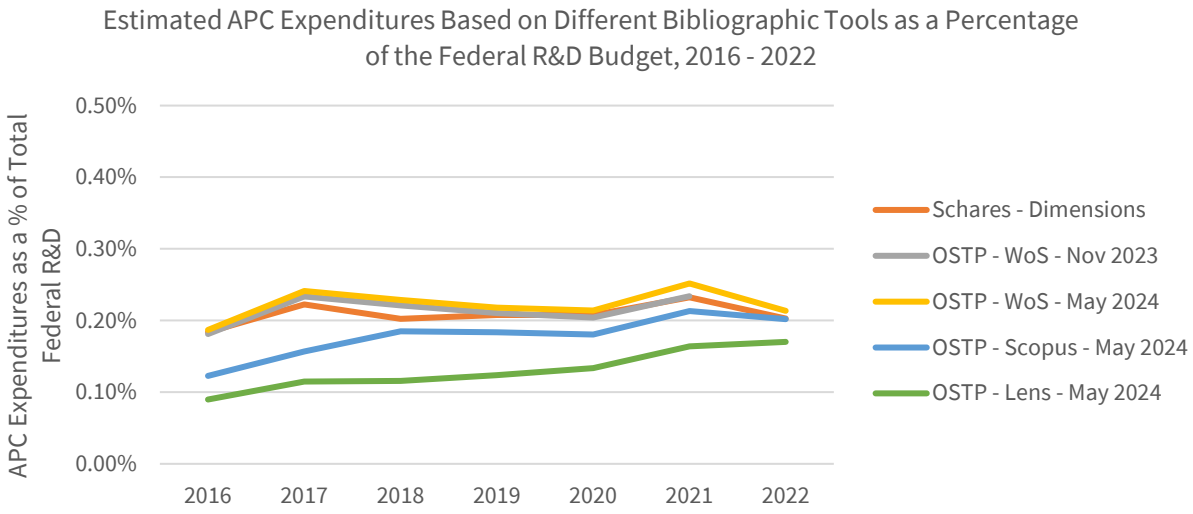

Figure 5. Estimated APC expenditures calculated from different bibliographic sources compared to federal research and development budgets for FY2016 – FY2022.

OSTP remains committed to promoting author choice in where and how researchers publish and make their research publicly accessible. Part of this commitment includes promoting a scholarly communication ecosystem that allows for different models of providing public access to coexist. As a result, OSTP will continue to work with its federal agency partners to monitor trends in the publishing landscape, both leading up to and after updated agency public access policies go into effect by December 31, 2025.

4. Efforts to Advance Research Integrity through Public Access Policies and Open Science Practices

There are several definitions for research integrity. In this report, OSTP refers to the following definition, consistent with the January 2022 *NSTC Report* on *Protecting the Integrity of Government Science*:[62]

[61] National Center for Science and Engineering Statistics (NCSES). (2023). *Federal R&D Funding, by Budget Function: Fiscal Years 2021–23.* Alexandria, VA: National Science Foundation. Retrieved from https://ncses.nsf.gov/pubs/nsf23324

[62] NSTC Scientific Integrity Fast-Track Action Committee. "Protecting the Integrity of Government Science." The White House Office of Science and Technology Policy, January 22, 2022. https://www.whitehouse.gov/wp-content/uploads/2022/01/01-22-Protecting_the_Integrity_of_Government_Science.pdf.

> Research integrity "promotes the use of honest and verifiable methods in proposing, performing, and evaluating research; reporting research results with particular attention to adherence to rules, regulations, guidelines; and following commonly accepted professional codes or norms."

A related concept is research misconduct, which OSTP defines as: "fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results, but does not include honest error or differences of opinion."[63]

The federal government has several policies in place to promote a culture of research integrity and prevent research misconduct. Public access policies have been designed to support and promote such a culture by including provisions around scientific data management and sharing. The 2013 Memorandum instructed research agencies to require their funded researchers to appropriately manage, document, and maximize access to scientific data produced over the course of the research lifecycle. These provisions, supported by agency guidance and efforts to strengthen capacity for data management and sharing, were designed to ensure that researchers maintained data needed to support their research results, promoting a culture of transparency and rigor.[64] The 2022 Memorandum strengthened these provisions by requiring that scientific data underlying peer-reviewed articles be shared at the time of publication, taking into account considerations around privacy, security, and intellectual property. Some agencies, such as NASA, also expect that researchers share software at the time of publication or at the end of the funding award.[65] These provisions reinforce policies that a number of publishers have put in place around data and software sharing, recognizing that increasing access to the data and tools underlying research findings enables members of the community to reproduce and build on research results, while also creating opportunities to make corrections if errors are found. This is one way in which federal public access policies, and open science[20] more broadly, enable and advance research integrity.

Despite efforts across the research community to promote research integrity and protect against research misconduct, breaches still occur. OSTP shares the Committees' concerns around such breaches and has been engaged in supporting efforts to advance high-quality and trustworthy research. To illustrate certain trends in research integrity in the scholarly publishing ecosystem, OSTP analyzed data retrieved in May 2024 from the Retraction Watch Database.[66] In publishing, a retraction is a mechanism by which papers with serious flaws can be flagged by the community and removed if an investigation finds the flags warranted. While there is often stigma attached with retractions, that the publishing system has mechanisms in place to retract flawed papers and that the research community

[63] See Federal Policy on Research Misconduct, published December 6, 2000: https://www.govinfo.gov/content/pkg/FR-2000-12-06/pdf/00-30852.pdf

[64] For example, NIH hosted a joint workshop in 2014 with the Nature Publishing Group and Science on reproducibility and rigor in research findings, convening journal editors representing 30 journals in which NIH-funded researchers often publish: https://grants.nih.gov/policy/reproducibility/principles-guidelines-reporting-preclinical-research.htm

[65] See NASA Science Mission Directorate Policy Document SPD-41: https://smd-cms.nasa.gov/wp-content/uploads/2023/05/ScientificInformationpolicySPD_41.pdf

[66] The Retraction Watch Database [Internet]. New York: The Center for Scientific Integrity. 2018. ISSN: 2692-465X. [Cited May 2024]. Available from: http://retractiondatabase.org/.

has the ability to raise concerns is evidence of a healthy ecosystem with a commitment to research integrity.

OSTP filtered results in the database for only those coded as "research articles," which are defined as "published item[s] describing a hypothesis, means of exploring the hypothesis, the results of the exploration, and the conclusions drawn from the results."[67] Figure 6 and Figure 7 illustrate the number of retractions, both by retraction year and publication year, from 1990 to 2023. There are currently efforts underway to standardize how retractions, removals, and expressions of concern are reported.[68] Comparison of the figures illustrates there is often a lag between a complaint and a decision to retract following an investigation.[69] OSTP separated out the data according to whether a retracted article had a U.S.-based author or not, demonstrating that the proportion of retracted articles authored by researchers in the United States is significantly lower compared to the global population, though still rising. Whether retracted articles had federal support or not is not indicated in the dataset, so OSTP was not able to parse a trend specific to federally funded research.

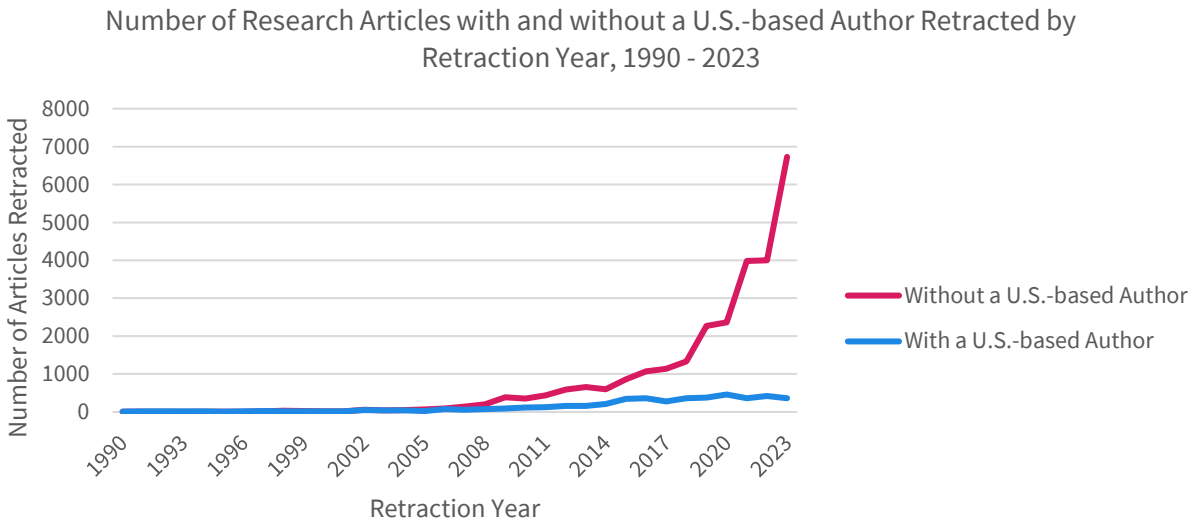

Figure 6. Research articles retracted with and without a U.S.-based author by retraction year from 1990 to 2023.

[67] See Retraction Watch Database User Guide Appendix C: Article Types: https://retractionwatch.com/retraction-watch-database-user-guide/retraction-watch-database-user-guide-appendix-c-article-types/

[68] See National Information Standards Organization (NISO) Communication of Retractions, Removals, and Expressions of Concern (CREC) Working Group: https://niso.org/standards-committees/crec

[69] The lag between a complaint and a decision to retract suggest that the number of retractions, particularly for articles published in more recent years, is likely and undercount.

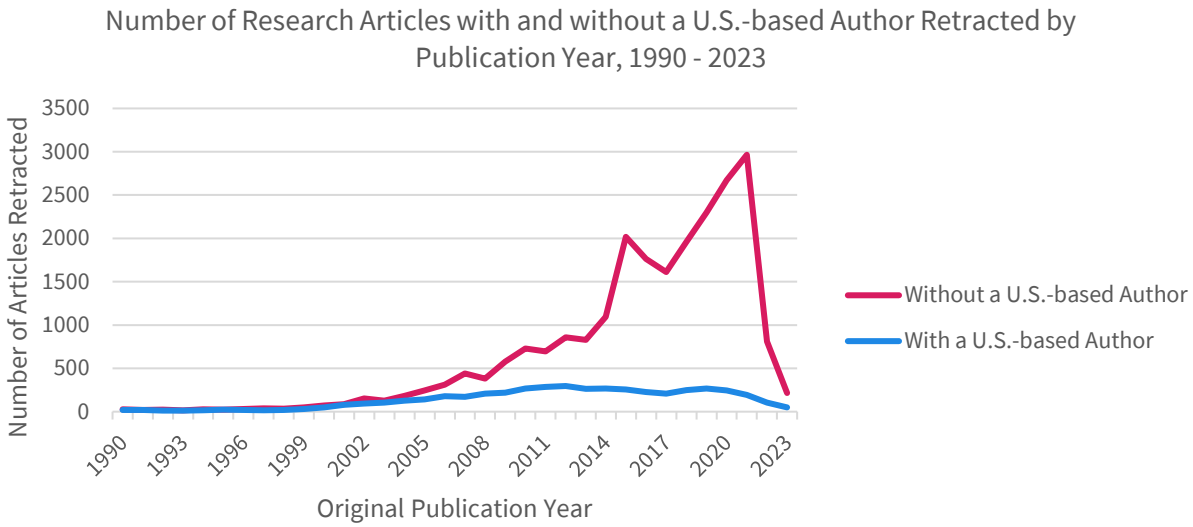

Figure 7. Research articles retracted with and without a U.S.-based author by publication year from 1990 to 2023.[69]

Notably, the spike in retractions in 2023 is largely attributed to the open access publisher Hindawi.[70,71] Over 8,000 articles were retracted by the publisher, owing largely to "paper mills," which the Committee on Publication Ethics (COPE) defines as "the process by which manufactured manuscripts are submitted to a journal for a fee on behalf of researchers with the purpose of providing an easy publication for them, or to offer authorship for sale."[72] There have been efforts across the broader publishing ecosystem, led in part by COPE and the International Association of Scientific, Technical, and Medical Publishers (STM) Integrity Hub, to understand the scale of the challenges presented by paper mills, as well as actions needed to address these challenges.[73] In addition, screening tools are under development to detect signs of paper mill activity.[74]

Importantly, while the *absolute number* of retractions has increased over the years, the *rate* of retractions should reflect that the total global output of research papers has also increased over the years.[75] As a rough illustration of retraction rates over time, OSTP compared the number of research articles published and later retracted in a given year with the total number of articles published in that

[70] Retraction Watch noted that due to the volume of retractions, there would be delays in entering every case into the database extending into 2024: https://retractionwatch.com/2023/12/28/the-year-at-retraction-watch-2023-whew/
[71] Hindawi was acquired by the publisher Wiley in January 2021. In September 2022, Wiley alerted the broader publishing community to the paper mill activity they discovered among Hindawi publications: https://scholarlykitchen.sspnet.org/2023/04/04/guest-post-addressing-paper-mills-and-a-way-forward-for-journal-security/
[72] COPE and STM. "Paper Mills — Research Report from COPE & STM." Committee on Publication Ethics, June 20, 2022. https://doi.org/10.24318/jtbg8ihl.
[73] See United2Act Consensus Statement: https://united2act.org/
[74] Brainard, J. (2023, May 9). Fake scientific papers are alarmingly common. *Science*. https://www.science.org/content/article/fake-scientific-papers-are-alarmingly-common
[75] Brainard, J., & You, J. (2018, October 25). What a massive database of retracted papers reveals about science publishing's "death penalty." *Science*. https://www.science.org/content/article/what-massive-database-retracted-papers-reveals-about-science-publishing-s-death-penalty

year, using data from the National Science Board's Science & Engineering Indicators (Figure 8).[76,77] OSTP compared the retraction rate globally ("Worldwide Authorship") with the rate for articles with at least one U.S.-based author ("With a U.S.-based Author"). While the retraction rate globally has risen, the rate for U.S.-authored publications has gone down to about 2-4 articles retracted per 10,000 articles published. OSTP notes that because of the lag between when a flag is raised and when an article is retracted, the retraction rate may shift up for articles published in more recent years.

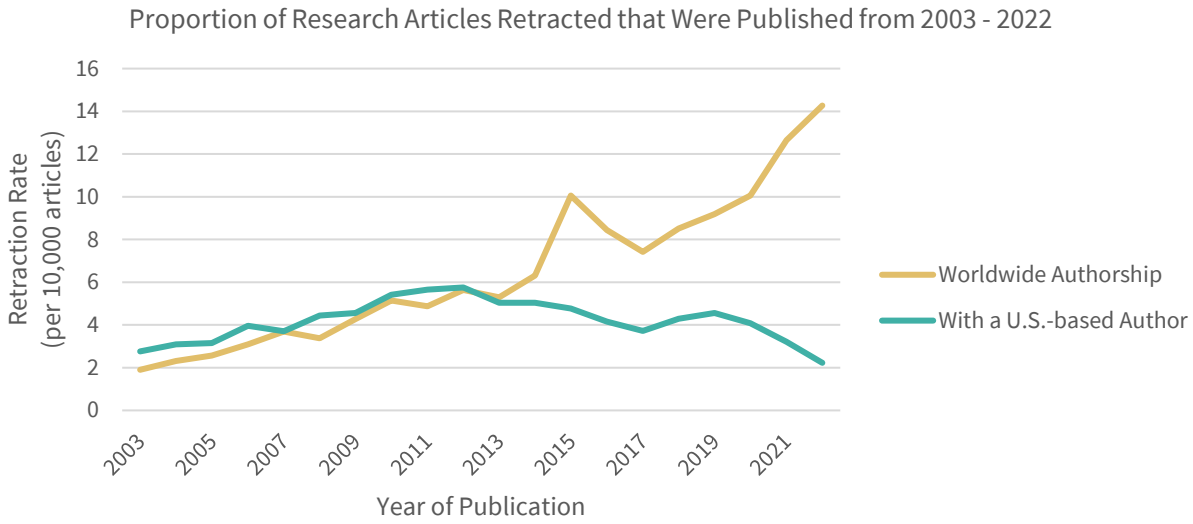

Figure 8. The proportion of research articles published between 2003 and 2022 that were subsequently retracted, The graph illustrates trends across the total pool of retracted research articles (compared to the global output of articles) versus only those with a U.S.-based author (compared to the U.S. output of articles).

Article retractions have been issued in the scholarly publishing community since before public access policies began taking effect in the United States, and federal public access policies do not appear to have caused a rise in retractions. The relatively rare occurrence of retractions can likely be attributed to steps the research and publishing community have taken to promote robust peer review and uphold research integrity, in addition to automated tools to detect factors like plagiarism before a manuscript even makes it to peer review. In addition, while retractions are often perceived to be synonymous with fraud and research misconduct, retractions can be caused by a number of factors, including honest error. OSTP analyzed retracted research articles published with at least one U.S.-based author to determine the most common reasons for retraction, the top 10 of which are shown in Table 3.

[76]National Science Board, National Science Foundation. 2023. Publications Output: U.S. Trends and International Comparisons. *Science and Engineering Indicators 2024.* NSB-2023-33. Alexandria, VA. Available at https://ncses.nsf.gov/pubs/nsb202333/.

[77] One caveat of this analysis is that the National Science Board used data from the bibliographic database Scopus to retrieve the number of articles from a selection of journals and conference proceedings in Science & Engineering in this timeframe. The Retraction Watch Database includes articles that would not be classified as "science and engineering" and OSTP included only "research articles" in its analysis, so the numerator and denominator are not necessarily matched. OSTP underscores this analysis provides a rough estimate of retraction rates, but further analysis is needed for more precise calculations.

Reason	Description Provided by Retraction Watch Database[78]
Concerns/Issues about Data	"Any question, controversy or dispute over the validity of the data"
Duplication of Image	"Also known as 'self-plagiarism.' Used when an image from an item written by one or all authors of the original article is repeated in the original article without appropriate citation."
Investigation by Journal/Publisher	"An evaluation of allegations by the Journal or Publisher"
Falsification/Fabrication of Data	"Intentional changes to data so that it is not representative of the actual finding"
Error in Data	"A mistake made in the data, either in data entry, gathering or identification"
Manipulation of Images	"The changing of the presentation of an image by reversal, rotation or similar action"
Error in Image	"A mistake made in the preparation or printing of an image"
Error in Analyses	"A mistake made in the evaluation of the data or calculations"
Concerns/Issues about Image	"Any question, controversy or dispute over the validity of the image"
Error in Results and/or Conclusions	"A mistake made in determining the results or establishing conclusions from an experiment or analysis"

Table 3. Top 10 reasons provided for retracted articles authored by at least one U.S.-based author.

As OSTP noted at the start of this section, public access and open science policies—as well as mutually reinforcing policies from the publishing community—are aimed at enabling the community to more readily find and correct these errors in an expeditious manner by increasing access to the data and tools underlying research findings. OSTP leveraged the sixth release of the Public Library of Science (PLOS) Open Science Indicators (OSI) dataset to demonstrate the growth of publications in PLOS journals with associated datasets made available in data repositories (Figure 9).[79] While the OSI dataset focuses on PLOS journals, the broader growth of data sharing over time can be attributed to funder and journal policies, as well as to scholarship and community efforts to more effectively translate policy guidance into practice, including: general capacity building for effective data management and sharing;[80] guidance for selecting a data repository that supports long-term and high-quality data preservation;[81] efforts to promote greater consistency across data sharing policies;[82] and infrastructure to better connect data and other research objects through metadata and digital persistent identifiers to promote adoption of data metrics.[83] Already, PLOS publications with a U.S.-based corresponding author have higher rates of making data available in a repository. OSTP anticipates this trend will grow as updated

[78] See: https://retractionwatch.com/retraction-watch-database-user-guide/retraction-watch-database-user-guide-appendix-b-reasons/

[79] Public Library of Science. "PLOS Open Science Indicators (Version 6)." *Figshare*, March 28, 2024. https://doi.org/10.6084/m9.figshare.21687686.

[80] Hanisch, R., Kaiser, D. L., Yuan, A., Medina-Smith, A., Carroll, B. C., & Campo, E. (2024). *NIST Research Data Framework (RDaF)*. https://doi.org/10.6028/nist.sp.1500-18r2

[81] National Science and Technology Council (NSTC). (2022). *Desirable Characteristics of Data Repositories for Federally Funded Research*. White House Office of Science and Technology Policy. https://doi.org/10.5479/10088/113528

[82] Hrynaszkiewicz, I., Simons, N., Hussain, A., Grant, R., & Goudie, S. (2020). Developing a Research Data Policy Framework for All Journals and Publishers. *Data Science Journal*, *19*(1), 5. https://doi.org/10.5334/dsj-2020-005

[83] Puebla, I., & Lowenberg, D. (2024). Building Trust: Data Metrics as a Focal Point for Responsible Data Stewardship. *Harvard Data Science Review*, *Special Issue 4*. https://doi.org/10.1162/99608f92.e1f349c2

federal public access policies go into effect by December 31, 2025. In 2023, NIH's Data Management and Sharing Policy[84] and NASA's Science Mission Directorate Policy SPD-41a[65] went into effect; both policies require data underlying publications be made publicly accessible, consistent with privacy, security, ethical, and intellectual property considerations.

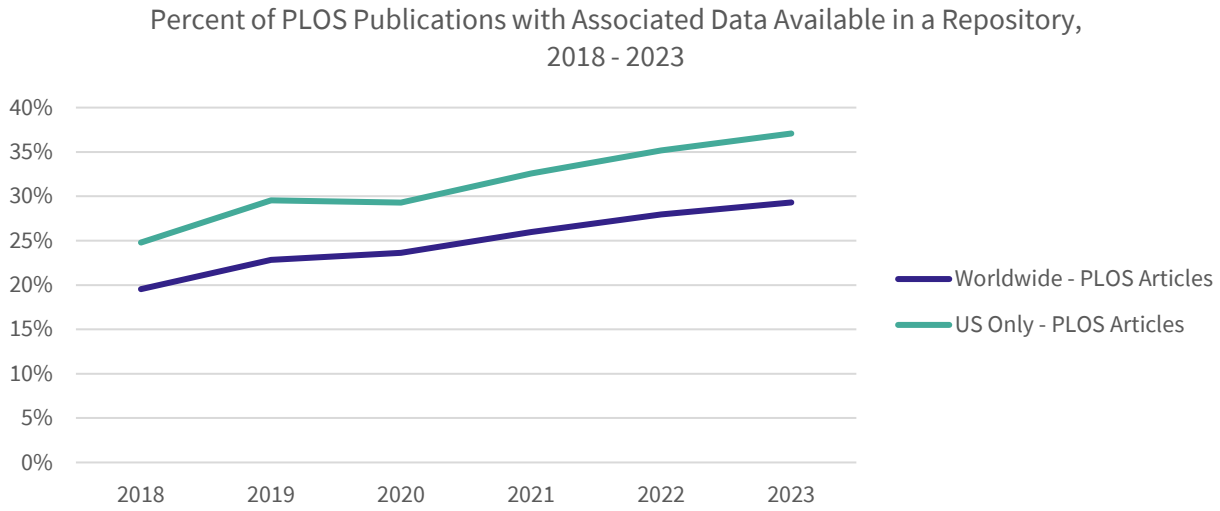

Figure 9. The percentage of articles published in PLOS journals with associated data available in a data repository from 2018 to 2023. Data are shown for PLOS articles worldwide and PLOS articles authored by a U.S.-based corresponding author.

While sharing of datasets associated with publications has grown, many journals still do not require peer review of the data, given the complexity of operationalizing what meaningful and robust peer review of datasets might look like.[85] Nevertheless, some journals and publishers have made advances in putting data peer review into practice and building the needed capacity among the research community to effectively review datasets. In addition to sharing data associated with publications, new forms of scholarly communication through data papers and data journals have emerged. Data papers are articles published in a peer-reviewed journal that describe a particular dataset and how the data were collected. Data journals specifically focus on publishing data papers, detailing "the methods used to create or collect the data, describe[ing] validation of the data, and facilitate[ing] the sharing and reuse of the data by other researchers."[86] These forms of communication place special emphasis on curated and high-quality datasets, creating incentives to share such data for broader reuse by the research community.[87]

The growing popularity of preprints may also provide another means of advancing research integrity. Preprints allow researchers to share their interim research results, allowing members of their scholarly communities to provide comment on these interim works to refine their analyses and build on their

[84] See NIH Data Management and Sharing Policy: https://sharing.nih.gov/data-management-and-sharing-policy
[85] Todd Carpenter. "What Constitutes Peer Review of a Data Set?" The Scholarly Kitchen, April 11, 2017. https://scholarlykitchen.sspnet.org/2017/04/11/what-constitutes-peer-review-research-data/.
[86] See: https://www.ncbi.nlm.nih.gov/books/NBK518737/
[87] Walters, W. H. (2020). Data journals: incentivizing data access and documentation within the scholarly communication system. *Insights: The UKSG Journal*, *33*. https://doi.org/10.1629/uksg.510

results. Preprints may also provide a host of benefits to early career researchers, including providing pathways for networking and collaboration.[88] Of course, the peer review process and publication in journals lends a sense of authority and validation from the community; nevertheless, opportunities for the research community to weigh in on preprints can help authors increase the quality of their work—or pursue a different line of inquiry—before an article is submitted for formal peer review. While public access policies only apply to peer-reviewed scholarly publications, some agencies like NIH have encouraged investigators to use interim research products like preprints to speed the dissemination of and enhance the quality of their work.[89]

Beyond data sharing and preprinting, there are broader cultural efforts to promote a culture of research integrity, which OSTP is committed to supporting. A joint 2022 report from COPE and STM on the problem of paper mills identified the pressure for researchers to publish to advance their careers as a major contributor.[72] OSTP discussed this pressure to "publish or perish," which values the volume of peer-reviewed publications above other contributions, in Section 6.3 of the November 2023 Report, as this was a major theme in a series of listening sessions OSTP hosted in summer 2023 with the early career researcher community.[3,90] This culture may incentivize researchers not only to use paper mills, but also to rush the publication process, which may lead to honest errors, or publish in "predatory journals," which COPE defines as "the systematic for-profit publication of purportedly scholarly content in a deceptive or fraudulent way and without any regard for quality assurance."[91] To help the research community navigate the changing landscape of publishing and protect against use of predatory journals, organizations have established best practices for open access publishing.[92] Funders, such as NIH, have also issued guidance to their grantees for identifying and choosing credible journals as the publishing industry continues to grow and evolve.[93]

To counter publishing pressures, COPE and STM recommended "engagement with institutions and funders to change incentives for researchers so that they no longer feel it necessary to use services that will give quick but fake publication." Efforts are underway to reform how research is evaluated and researchers rewarded. The Declaration on Research Assessment (DORA), for example, is developing more meaningful and transparent metrics.[94] More recently, in April 2024, a group of over 25 research information experts representing organizations around the world published the "Barcelona Declaration

[88] Sarabipour, S., Debat, H. J., Emmott, E., Burgess, S. J., Schwessinger, B., & Hensel, Z. (2019). On the value of preprints: An early career researcher perspective. *PLOS Biology*, *17*(2), e3000151. https://doi.org/10.1371/journal.pbio.3000151

[89] See NOT-OD-17-050, Reporting Preprints and Other Interim Research Products: https://grants.nih.gov/grants/guide/notice-files/NOT-OD-17-050.html

[90] OSTP. (2023, July 11). *Readout of OSTP Open Science Listening Sessions with Early Career Researchers*. White House Office of Science and Technology Policy. Retrieved from https://www.whitehouse.gov/ostp/news-updates/2023/07/11/readout-of-ostp-open-science-listening-sessions-with-early-career-researchers/

[91] COPE Council. "Discussion Document: Predatory Publishing." *Publicationethics.org*. COPE, November 2019. https://doi.org/10.24318/cope.2019.3.6.

[92] COPE, DOAJ, OASPA, & WAME. (2013, December). Principles of Transparency and Best Practice in Scholarly Publishing, 4.0. Retrieved from DOAJ: https://doaj.org/apply/transparency/

[93] See NOT-OD-18-011, Statement on Article Publication Resulting from NIH Funded Research: https://grants.nih.gov/grants/guide/notice-files/NOT-OD-18-011.html

[94] DORA. (2012). DORA – San Francisco Declaration on Research Assessment (DORA). Retrieved from https://sfdora.org/read/

on Open Research Information," which reiterates the need to advance responsible research assessment that prioritizes quality and transparency.[95] Related initiatives include both the community-led organization Make Data Count,[96] which focuses on development of open and responsibly created metrics for research data, as well as the Higher Education Leadership Initiative for Open Scholarship (HELIOS),[97] a cohort of colleges and universities coordinating to advance open scholarship. The U.S. Government remains engaged in these efforts as federal funders are a key stakeholder in advancing and adopting responsible and meaningful research assessment practices and promote a culture of research integrity.

5. Continuing Trends in Peer Review

High-quality peer review is an enabler of research integrity and a vital service publishers provide. Recognizing the importance of peer review, the 2022 Memorandum emphasizes public access to *peer-reviewed* scholarly publications. In the previous section, OSTP discussed how public access and open science efforts across the U.S. government support research integrity and may enhance the peer review process by enabling greater transparency of research results. Nevertheless, OSTP recognizes that the peer review system is an imperfect one, noting both long-standing trends that predate any changes to federal public access policies, as well as efforts for reform, such as:

- **Documented biases in the peer review system.** OSTP's November 2023 Report discussed long-standing inequities stemming from biases, whether explicit or implicit, in the peer review and editorial system. Biases include: "status bias," whereby prominent researchers are more likely to receive favorable reviews than relatively unknown authors;[98] "content bias," or biases a reviewer may hold towards a specific topic or outcome irrespective of the quality of the methods or results;[99] biases towards author characteristics, such as institutional affiliation, perceived sex or gender, or perceived race or ethnicity; and "publication bias," or a preference to publish positive or statistically-significant results rather than negative or non-confirmatory results.[100]
- **Growth in article output has strained the pool of reviewers.** As OSTP discussed in its November 2023 Report, the number of articles published both worldwide and in the United States has grown enormously over the years. From 1996 to 2020 the volume tripled from just under 1 million to 2.9 million articles published per year.[101] This growth is due to a variety of factors including the

[95] Kramer, B., Neylon, C., & Waltman, L. (2024). *The Barcelona Declaration on Open Research Information*. https://doi.org/10.5281/zenodo.10958522

[96] See Make Data Count: https://makedatacount.org/

[97] See HELIOS: https://www.heliosopen.org/

[98] Huber, J., Inoua, S., Kerschbamer, R., König-Kersting, C., Palan, S., & Smith, V. L. (2022). Nobel and novice: Author prominence affects peer review. Proceedings of the National Academy of Sciences of the United States of America, 119(41), e2205779119. https://doi.org/10.1073/pnas.2205779119

[99] Haffar, S., Bazerbachi, F., & Murad, M. H. (2019). Peer Review Bias: A Critical Review. *Mayo Clinic Proceedings*, *94*(4), 670–676. https://doi.org/10.1016/j.mayocp.2018.09.004

[100] McKenzie, N. D., Liu, R., Chiu, A. V., Chavez-MacGregor, M., Frohlich, D., Ahmad, S., & Hendricks, C. B. (2022). Exploring Bias in Scientific Peer Review: An ASCO Initiative. *JCO Oncology Practice*, *18*(12), 791–799. https://doi.org/10.1200/OP.22.00275

[101] National Science Board, National Science Foundation. (2021). Publications Output: U.S. and International Comparisons. In *Science and Engineering Indicators* 2022. Alexandria, VA. Retrieved from https://ncses.nsf.gov/pubs/nsb20214/

digitization of scholarly publishing, as well as cultural factors like the pressure to publish to advance careers. With this growth comes a need for more peer reviewers, increasing the requests to peer review. A 2018 report on the state of peer review published by Publon's notes that: "75% of journal editors say that 'finding reviewers and getting them to accept review invitations' is the hardest part of their job."[102] The report also notes reviewers most commonly declined because they felt their expertise was not well matched to the article and/or they had too many other constraints on their time. Publisher efforts to increase the diversity of the peer reviewer pool may also cause additional strain on women and underrepresented scholars, who already disproportionately take on additional service roles at their institutions, which are often categorized as "non-promotable" work.[103,104]

- **Lack of credit or incentives for peer review.** Researchers who serve as peer reviewers are often not credited for their contributions to the scholarly communication ecosystem. Researchers dedicate unpaid and otherwise generally uncompensated time to review research articles and serve on editorial boards.[105] A 2021 study estimated that U.S.-based researchers contributed over $1.5 billion on reviews in time and salary.[106] While there is debate around ethical concerns associated with paying peer reviewers for their service, publishers, research institutions, and funders can still take steps to credit peer reviewers for this work and ensure it is career-enhancing.
- **Delays between submission and completion of the peer review process.** The growing volume of publications and demands on the peer review pool have also contributed to delays between submission of manuscripts and a determination of whether to accept or reject a paper. Different fields of research also have differing delays between submission of a manuscript and completion of the peer review process.[107]

A number of publishers, journals, and researcher-led initiatives across the scholarly communication ecosystem have worked to address some of these concerning trends, including through:

- **Efforts to diversify the pool of reviewers and editorial boards.** OSTP has observed commendable efforts across the publishing industry to diversify their slate of peer reviewers and membership of their editorial boards, including by career level and geography. A 2021 survey

[102] Publons. (2018). *Publons' Global State of Peer Review 2018*. https://doi.org/10.14322/publons.gspr2018
[103] Williamson, T., Goodwin, C. R., & Ubel, P. A. (2021). Minority Tax Reform — Avoiding Overtaxing Minorities When We Need Them Most. *New England Journal of Medicine*, *384*(20), 1877–1879. https://doi.org/10.1056/nejmp2100179
[104] Babcock, L., Recalde, M. P., Vesterlund, L., & Weingart, L. (2017). Gender differences in accepting and receiving requests for tasks with low promotability. *American Economic Review*, *107*(3), 714-47. Retrieved from: https://gap.hks.harvard.edu/breaking-glass-ceiling-%E2%80%9Cno%E2%80%9D-gender-differences-declining-requests-non%E2%80%90promotable-tasks
[105] This is another way in which American taxpayers have indirectly supported costs associated with scholarly publishing, as they provide financial support to researchers whose salaries may be partially paid by federal research grants or directly to federal researchers.
[106] Aczel, B., Szaszi, B., & Holcombe, A. O. (2021). A billion-dollar donation: estimating the cost of researchers' time spent on peer review. *Research Integrity and Peer Review*, *6*(1), 14. https://doi.org/10.1186/s41073-021-00118-2
[107] Björk, B.-C., & Solomon, D. (2013). The publishing delay in scholarly peer-reviewed journals. *Journal of Informetrics*, *7*(4), 914–923. https://doi.org/10.1016/j.joi.2013.09.001

conducted by COPE found that 69% of journals and publishers are actively working to increase their reviewer pool, while 29% reported their outlet had achieved its ideal level of diversity.[108]

- **Experiments to promote greater transparency in the peer review process.** Open peer review is an umbrella term for a variety of strategies to promote transparency and accountability in the peer review process, including by "making reviewer and author identities open, publishing review reports, and enabling greater participation in the peer review process."[109] Open peer review efforts are not a new phenomenon; publishers like the British Medical Journal and BioMed Central have advanced these practices for over two decades; however, broader adoption has lagged.[110] Nevertheless, more publishers are experimenting with different approaches to open peer review. For example, IOP Publishing has adopted transparent peer review, which allows the community to see the full peer review history, including reviewer reports and decision letters to the authors, alongside the article.[111] IOP Publishing's efforts have been enabled by Clarivate's Transparent Peer Review (TPR) service to facilitate needed infrastructure to enable TPR; by 2022, the service, which was launched in 2018, was used by 123 journals across 7 publishers, including Wiley and MIT Press.[110] Adoption of open peer review does require culture change; while earlier career researchers are supportive of these efforts, later stage researchers are more hesitant to adopt.[102]
- **Efforts to provide credit for peer review.** Publishers and members of the research community have made efforts to provide credit and recognition to peer reviewers. Some publishers have adopted use of a Reviewer Recognition Service, allowing peer reviewers reviewing articles for participating journals to opt-in to have reviews for participating journals posted to their reviewer profile, allowing them to grow a verified record of their contributions. In addition, some publishers offer discounted APCs to their reviewers and others offer incentives like Continuing Medical Education credits to peer reviewers for reviewing specific types of articles.
- **Community-led efforts advancing preprint review and providing peer reviewer training.** Preprints offer researchers an opportunity to gain input on their work before deciding whether and where to submit their manuscripts for formal peer review and publication. Community-led efforts like PREreview offer opportunities to train communities of researchers, particularly early career researchers and researchers from underrepresented backgrounds, on the peer review process by using preprints.[112]

The above are just a sampling of long-standing trends in peer review that OSTP and its federal partners continue to monitor in advancing efforts to promote the vitality, integrity, diversity, and equity of the scholarly communication ecosystem, while continuing to advance public access to these important taxpayer-funded research outputs.

---

[108] COPE. (2021, October). *Bias in peer review*. COPE: Committee on Publication Ethics. https://publicationethics.org/resources/forum-discussions/bias-peer-review

[109] Ross-Hellauer, T. (2017). What is open peer review? A systematic review. *F1000Research*, *6*(588), 588. https://doi.org/10.12688/f1000research.11369.2

[110] Halevi, G. (2022, September 19). *The current state of open peer review*. Clarivate. https://clarivate.com/blog/the-current-state-of-open-peer-review/

[111] Holst, F., Eggleton, K., & Harris, S. (2022). Transparency versus anonymity: which is better to eliminate bias in peer review? *Insights*, *35*(0), 16. https://doi.org/10.1629/uksg.584

[112] Hindle, S., & Saderi, D. (2017, October 25). *PREreview — a new resource for the collaborative review of preprints*. ELife. https://elifesciences.org/labs/57d6b284/prereview-a-new-resource-for-the-collaborative-review-of-preprints

6. Conclusion

This report has outlined developments in the scholarly communication landscape since OSTP's November 2023 Report to the Committees, estimated the proportion of federal research and development expenditures that have gone towards article processing charges to publish federally funded research (between 0.09 to 0.25 percent, depending on the bibliographic source used), and elaborated on trends in research integrity and peer review. Throughout the report, OSTP has underscored that the landscape of scholarly publishing is rapidly evolving and pointed to data needs to better monitor these trends. OSTP greatly appreciates the commitments of the Appropriations Committees of the House and the Senate to realizing our shared goal of increasing access to taxpayer-supported research for the benefit of all. OSTP reaffirms its commitment to collaborative implementation of the 2022 Memorandum with agencies across the federal government, engaging with diverse stakeholders to ensure that all Americans benefit from access to and use of federally funded research and data in discovery, innovation, and policymaking.