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## RESEARCH ARTICLE

# Open But Hidden: Open Access Gaps in the National Science Foundation Public Access Repository

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## ABSTRACT

**Introduction:** In 2022, the U.S. government released new guidelines for making publicly funded research open and available. For the National Science Foundation (NSF), these policies reinforce requirements in place since 2016 for supported research to be submitted to the Public Access Repository (PAR).

**Methods:** To evaluate the public access compliance of research articles submitted to the NSF-PAR, this study searched for NSF-PAR records published between 2017 and 2021 from two research intensive institutions. Records were reviewed to determine whether the PAR held a deposited copy, as required by the 2016 policies, or provided a link out to publisher-held version(s).

**Results:** A total of 841 unique records were identified, all with publicly accessible versions. Yet only 42% had a deposited PDF version available in the repository as required by the NSF 2016 Public Access Policy. The remaining 58% directed instead to publisher-held versions. In total, only 55% of record links labeled “Full Text Available” directed users to a publicly accessible version with a single click.

**Discussion:** Records within PAR do not clearly direct users to the publicly accessible full text. In almost half of records, the most prominently displayed link directed users to a paywall version, even when a publicly available version existed. Records accessible only through the CHORUS (Clearing House for the Open Research of the United States) initiative were further obscured by requiring specialized navigation of publisher-owned sites.

**Conclusion:** Despite having a repository mandate since 2016, NSF compliance rates remain low. Additional support and/or oversight is needed to address the additional requirements introduced under the 2022 memo.

**Keywords:** Nelson Memo, National Science Foundation, Public Access Repository, Scholarly Communications, Federal Open Access Policy, CHORUS Initiative

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## IMPLICATIONS FOR PRACTICE

1. In contrast to the NIH Public Access Policies, compliance with the NSF Public Access Policy remains low. Similarly, without any apparent consequences for non-compliance, there has been a marked decrease in the overall number of submitted PAR records in the years since the 2016 policies went into effect.
2. While all the publications identified in this study had publicly accessible versions, most did not have full-text PDF versions available within the NSF-PAR as required under the 2016 policies. For the records under examination, the NSF-PAR functioned more as a directory of publisher links than a repository.
3. When navigating NSF-PAR search results and “Full Text Available” links, in more than half of cases users will *not* be directed to a publicly accessible version. Instead, users will need to navigate multiple PAR record details and/or possess specialized knowledge of publisher sites to access the publicly available full text. Awareness of these barriers or impediments to supposedly open versions of publications is essential to librarians and others who advocate for openness in the scholarly record. Monitoring the real, practical effects of implementation success or failure is necessary for informing future advocacy efforts.
4. While official policy language primarily discusses requirements for funded researchers and awardees, the NSF explicitly designated the awardee institutions as the responsible entity for ensuring repository compliance. While there currently seems to be no consequence for non-compliance with the NSF policies, librarians and information professionals working to support their institutional open access and copyright compliance initiatives should be aware of the upcoming federal policies.

## INTRODUCTION

In August of 2022, the U.S. White House Office of Science and Technology Policy (OSTP) released a Memorandum on Ensuring Free, Immediate, and Equitable Access to Federally Funded Research (Nelson, 2022). Known more briefly as the Nelson Memo, the policy directs all federal agencies to update their policies to require immediate public release of supported research outputs and to ensure transparent procedures for compliance. Federal agencies are directed to have updated policies in place by the end of 2024 and have them go into effect no later than the end of 2025. The 2022 memo builds on the 2013 Memorandum on Increasing Access to the Results of Federally Funded Research from the same office, which required only agencies that awarded over \$100 million annually to develop plans for public access resulting from those awards by 2016 (Holdren, 2013). The U.S. National Science Foundation (NSF) currently awards over \$8 billion dollars annually and in 2015 released a dedicated repository

known as the NSF Public Access Repository, or PAR, available at <https://par.nsf.gov>. The system launched for voluntary submissions in 2015, with the intention of mandatory deposits beginning in 2016 (NSF, 2015). Notably, the policy also included language that “NSF will require awardee institutions to ensure that authors of articles and papers that fall within the scope of this plan (as defined in Section 2.0) deposit copies of the author’s final accepted peer-reviewed manuscript or the version of record in the PDF/A standard” (NSF, 2015). This language designates the awardee’s institution as the responsible party for ensuring compliance and stipulates the PDF as the expected format.

In response to the 2022 Nelson Memo, the NSF offered their updated policy plan under the Public Access Plan 2.0, created in February 2023 with implementation expected by December 31, 2024. Most notably, the plan outlines immediate availability to peer-reviewed publications and associated data arising from their awards and programs, disallowing publisher-imposed embargoes. Language in the Public Access Plan 2.0 reinforces that “beginning with new awards starting January 2016, NSF-funded researchers have been required to deposit publications stemming from funded research in NSF-PAR as PDFs” (NSF, 2023). However, very little examination seems to exist regarding the extent to which compliance with the 2016 NSF policy has been achieved or the extent to which the infrastructure exists to achieve the goals laid out by the Nelson Memo and the Public Access Plan 2.0.

## LITERATURE REVIEW

Among the U.S. federal agencies, the National Institutes of Health (NIH) has led the adoption of public access policies beginning with their voluntary policy drafted in 2004 (NIH, 2005). In April 2008, the NIH Public Access Policy went into effect, requiring all research publications supported in whole or in part through NIH public dollars be made freely available to public users, with an optional 12-month publisher embargo period (NIH, 2008). Concurrent with the 2013 Public Access Memo regarding all granting agencies with over \$100 million in annual awards, the NIH released the Public Access Compliance Monitor, allowing institutions to track the publication compliance of their affiliated investigators (NIH, 2013). With this monitoring tool in place, the NIH sought to drive compliance by also announcing an imposed delay in the processing of continuing grant awards to those investigators and research groups found to be non-compliant with policy following July 31, 2013 award dates (NIH, 2013). As of January 2021, over 760,000 full-text manuscripts had been made freely available in PubMed Central (National Library of Medicine, 2023), with an annual compliance rate of around 90% for NIH-funded research (Larivière & Sugimoto, 2018).

Conversely, the NSF did not implement their public access mandate until 2016. One study, conducted in 2018, noted an initial compliance rate of only 47% of publications resulting

from applicable NSF awards appearing in the NSF-PAR (Larivière & Sugimoto, 2018). This rate is in the lower ranges of federal compliance rates reported for public access research mandates in other countries (75% in Australia, 58% in Spain, and 70% in Canada) but falls drastically short of the compliance rate noted for the NIH (Borrego, 2016; Kirkman & Haddow, 2020; Scaffidi et al., 2021).

According to NSF guidelines, it is the responsibility of the principal investigator (PI) or co-PI of the grant to deposit a copy of the final accepted manuscript or open access version of any peer-reviewed, published articles into the NSF-PAR (NSF, n.d.). Publication information can be provided either manually or imported from the publisher through the unique article digital object identifier (or DOI). The PAR then makes the document available to the public after any appropriate embargo period has passed. Relying on author effort to populate content into a repository has been shown to be difficult across a variety of settings (Lovett et al., 2017; Kipphut-Smith et al., 2018). Perhaps anticipating the difficulties of relying solely on author effort to achieve policy compliance, the NSF and other federal agencies affected by the 2013 memo welcomed partnership with the academic publishing community. In response to the significant changes in federally funded scholarly communication brought forth by the 2013 memo, an alliance of academic publishers developed an approach to use their existing infrastructure to support funder policies (Scott-Lichter, 2013). This alliance of publishers would collectively integrate the OSTP open access requirements into the publishing process, resulting in the service called the Clearing House for the Open Research of the United States, or CHORUS ([www.chorusaccess.org](http://www.chorusaccess.org)). CHORUS members agree to make publicly accessible versions of the published manuscripts resulting from participating funding agencies appearing in their journals available on their sites and linked by the article DOI.

Open access to scholarly work continues to be an important issue for academic librarians, along with the concern for barriers that prevent the implementation of widespread open strategies (Association of College and Research Libraries, 2022). In a review of the literature, the authors do not find a robust review, nor case studies, of whether the implementation of the 2013 OSTP memo policies have been successful. As librarians are commonly the advocates of open access at their institutions, and take on the challenging task of author compliance with open access mandates (Association of College and Research Libraries, 2022), a study of the degree of NSF compliance is of interest to librarians.

With the impetus of the Nelson Memo, and the aforementioned processes in mind, the study described here sought to clarify the accessibility of publications within the NSF-PAR, and the adherence of freely available access via the expected/required PDF formats. The study also sought to determine whether there were any notable trends regarding publisher policies on the availability of publications to the version of record or final author accepted manuscripts.

By illuminating the current landscape of NSF public access availability with the designated repository, study authors hoped to raise awareness of the challenges that may be facing our university investigators in meeting the updated public access policies and provide evidence for research support services that may be needed to address issues or points of concern.

## METHODS

### Extracting affiliation records from NSF-PAR

Funded publication records were collected from the NSF-PAR (<https://par.nsf.gov/>) in January 2023. Searches were independently conducted for “Emory”, “Georgia Institute of Technology”, and “Georgia Tech” in the Creators/Authors field available under the Advanced Search options and limited to publication dates 2017–2021. These dates reflect the range of years in which the Public Access Policy would have been in full effect, and by when all allowed embargos would have expired. Search results were then exported as Excel files using the PAR Save As functions. Results were combined for a unique total of 1269 records. To verify the respective affiliations of interest and collaborative records between the institutions, DOIs were then searched in the Web of Science Core Collection. An author affiliation column was then added to the combined spreadsheet to indicate the respective institution(s). Records with a Web of Science affiliation listing that did not include Emory University or Georgia Institute of Technology were marked “no.” All remaining records unavailable for examination in Web of Science were manually reviewed for the relevant affiliations. A total of 428 records were removed from the study for false positive affiliations, leaving 841 records, including 87 jointly co-authored between the two institutions.

### Determining full text available

When searching the PAR, users are immediately presented with a “Full Text Available” link following each record listed on the results summary page. Each of the identified 841 records were then manually examined in PAR to note whether the record results summary linked directly to the repository full text PDF (example: <https://par.nsf.gov/search/term:10064237>), or to a publisher version through the provided “Full Text Available” link (example: <https://par.nsf.gov/search/term:10302676>). These two yes/no determinations of availability were noted in the combined spreadsheet.

When the “Full Text Available” link presented on the results page linked to a paywalled version, records were further examined to determine whether the public access links were listed instead in the record details. In most cases, to access this uploaded version, the user would need to by-pass the Full Text Available link provided on the record summary and instead click into the PAR record details to view the deposited manuscript (example with

available repository manuscript: <https://par.nsf.gov/biblio/10302676>; example with no manuscript available: <https://par.nsf.gov/biblio/10115845>).

Finally, when there were no additional repository links available in the record details, and the provided “Full Text Available” links appeared to land on paywalled versions, it was further noted whether the user needed to have specialized awareness of the CHORUS initiative to navigate to the open access version from the provided link (example: <https://par.nsf.gov/search/term:10121805>). While users without subscription access to the journal in question will initially be directed to the standard paywall, those familiar with CHORUS publishers could still navigate to the public access version by (in the case of the provided Wiley example) clicking on the About and/or Information tabs to be provided an additional link to the Author Manuscript.

### **Unified publisher listings**

In order to complete publisher summaries of study findings, the publisher information included in the exported data file was modified to assign consistent publisher listings and to add in missing publisher information. Initial assignments were made using the DOI Prefix look-up available at <https://gist.github.com/TomDemeranville/8699232> (Demeranville, n.d.). PAR records that provided only “<https://doi.org/null>” were verified by ISSN in UlrichsWeb Global Serials Directory (<http://ulrichsweb.serialssolutions.com>). Records without DOI, Publisher, or ISSN provided information were noted to be conference or other presentation proceedings. Publisher determinations were added to a total of 312 records, with 51 records remaining blank.

## **RESULTS**

### **Summaries of full text availability**

Study results identified 841 unique records from 2017 through 2021 available in the NSF-PAR resulting from projects awarded to investigators affiliated with Emory University or Georgia Institute of Technology. A total of 87 records (10%) were determined to be the results of collaborative efforts.

Findings showed that 462 records (55%) listed in PAR immediately directed users to a full text version when clicking on the “Full Text Available” link provided in the record results summary, either through a direct publisher link (46%) or an available PDF (9%). Of the remaining records, 175 records (21%) directed users to a publisher paywall version when clicking on the “Full Text Available” link, despite having a deposited public access copy available within the repository. In total, 353 records (42%) were available as a PDF within the repository. However, to access the repository version, users will generally need to by-pass the “Full Text Available” link provided in the record summary (see [Figure 1](#)) and instead click on the hyperlinked

**Note:** When clicking on a Digital Object Identifier (DOI) number, you will be taken to an external site maintained by the publisher. Some full text articles may not yet be available without a charge during the embargo (administrative interval).

[What is a DOI Number?](#)

Some links on this page may take you to non-federal websites. Their policies may differ from this site.

1. ACE of space: estimating genetic components of high-dimensional imaging data  
<https://doi.org/10.1093/biostatistics/kxz022>

Risk, Benjamin B. ; Zhu, Hongtu ( June 2019 , Biostatistics)

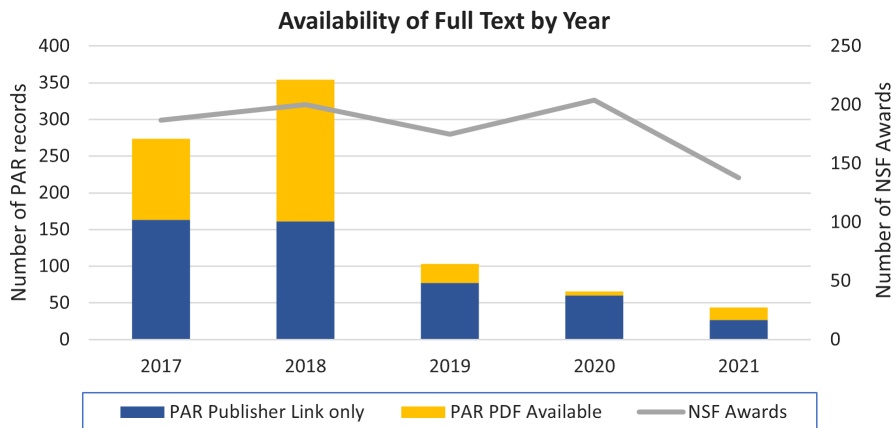
[Full Text Available](#)

**Figure 1.** An example of an NSF-PAR record summary showing the “Full Text Available” link which may or may not take users to the full text.

record title. Once within the record details, readers may find a link to the “Free Publicly Accessible Full Text” available on the right-hand sidebar. The remaining 488 records (58%) had no deposited full text and instead relied on publisher links to provide reader access.

### Full text available by year

This study noted a dramatic drop-off in institutionally affiliated records provided in NSF-PAR across the five-year study period, with a marked increase in the reliance on publisher-provided access rather than deposit of public access versions within the repository. Records from 2018 represent both the highest number of records ( $n = 354$  or 43% of study records), as well as the highest rate of deposited full text records (55%) versus exclusive reliance on publisher link outs (45%). By 2021, only 44 records appear in the repository, with 61% relying exclusively on publisher-provided link outs. This trend does not correspond to the combined NSF awards granted to the two institutions for the corresponding years, shown in [Figure 2](#) by start date.



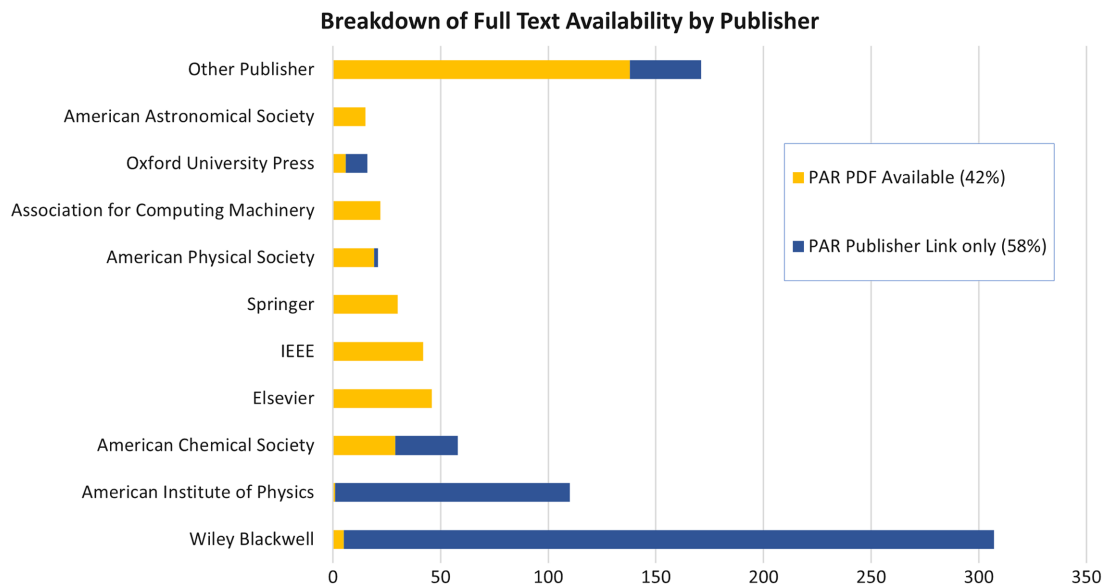
**Figure 2.** NSF-PAR records available by year and broken out by full text availability with trendline showing the respective number of NSF awards by year.



### Full text availability by publisher

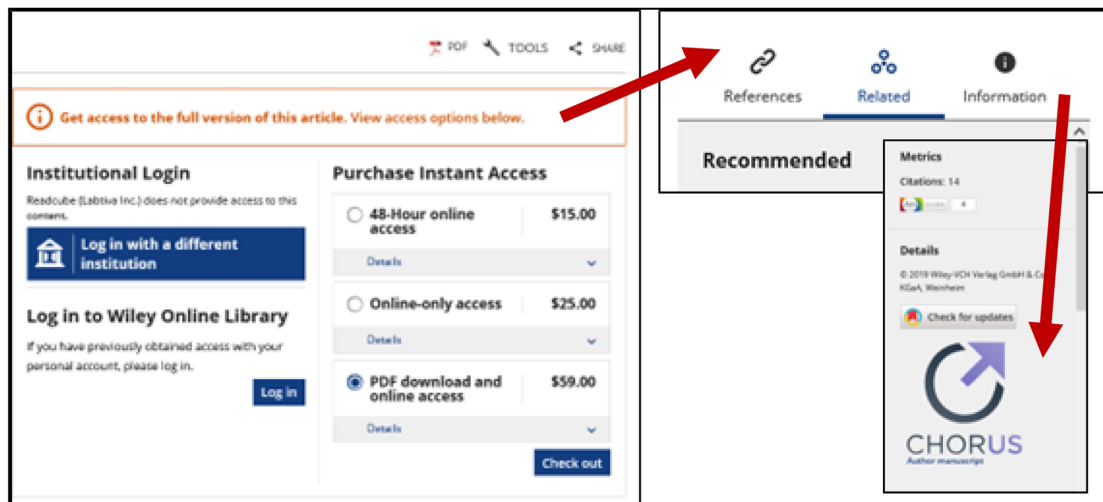
Following the validation of university affiliation, 43% (n = 362) of records extracted from the NSF-PAR included no explicitly named publisher. An additional 6% (n = 48) of records included only “DOI PREFIX” information as the listed publisher (example: “DOI PREFIX: 10.1029”). Combined, this represents almost half of published records that included no explicitly named publisher in the PAR record metadata. Similarly, 9% (n = 74) of records extracted included no DOI information, listing instead “https://doi.org/null.” An additional 0.6% (n = 5) offered misformatted DOIs such as “https://doi.org/https://doi.org/XXX” or “https://doi.org/doi.org/XXX.” Misformatted DOIs represent only a minor, and easily identified, issue in the exported records but are indicative of a lack of standardization or validity control applied to PAR record fields. In contrast, 95% of records included ISSN numbers. The 88 records without ISSN were manually examined and 45 confirmed to be conference proceedings and presentations without formal publication versions. However, the high inclusion rate of relevant ISSNs, even for records with no publisher or DOI information, seems to indicate this is a system-automated field based on the author-provided journal name.

Once the explicit publisher names were obtained and unified for each record (based on ISSN, DOI prefix matching, and manual searching), there was a marked relationship noted between the publisher and adherence to the full text availability. A total of 59 publishers were included in the dataset, with the top 10 publishers having produced 80% of records. Figure 3 shows the full text accessibility breakdown by the top publishers.



**Figure 3.** Breakdown of full text availability from the top 10 publishers of associated NSF-PAR records.

This breakdown of full text availability by publisher highlighted the integration of publisher efforts into the public access process, the CHORUS initiative (<https://www.chorusaccess.org>). Formed partly in response to the 2013 Public Access Memo, CHORUS is a publisher-led initiative that seeks to meet federal sharing requirements while still allowing publishers to retain control of published research, not only through the final published version but also the author accepted manuscript (Crotty, 2013). When examining full text link outs provided in the NSF-PAR, initially 37% of links were described as directing only to the paywall version of the article. Upon closer examination (and additional title searching approaches), it was discovered that readers could, in fact, navigate to a free version if they knew the correct steps to follow. Wiley Blackwell offers the most consistent example, requiring users to ignore the commonly presented read options and paywall notifications and instead to click on the information tab in the article sidebar, then scroll down to the link to “Author Manuscript” provided just under the CHORUS icon (see Figure 4).



**Figure 4.** Screenshot of webpage click throughs required to access the CHORUS-provided manuscript.

The two most frequent publishers in the dataset were American Institute of Physics (AIP) and Wiley Blackwell, both participants in CHORUS. At the time of the initial study, both publishers linked exclusively to paywall pages, requiring readers to independently navigate to the CHORUS access versions. However, in April of 2023, AIP updated its journal webpages, updating links to provide full text access to the version of records for CHORUS associated publications. For records associated with these two publishers, only two PAR records provided a full text PDF deposit available through the record full details pages. Conversely, 99.5% relied on external publisher links, with 53% ( $n = 204$ ) reliant on readers’ knowledge and initiative to follow the required CHORUS navigation steps.

## DISCUSSION

This study examined the compliance rates of authors responding to a mandate from the funding organization (NSF) in making the results of their research publicly available. The intentions of the OSTP memos are to make federally funded research available to a wider audience, something librarians have been advocating for many years. Our results suggest that compliance remains incomplete, and even when provided in an open format, access may be obscured. These results highlight the still difficult nature of bringing about author compliance with public access policies, even when the policy is mandatory.

Our findings show that there is a notable decrease in the number of available open access versions from 2017 to 2021. Any embargoes associated with the publication of any of these articles included in our study should have expired by now, so existing embargoes should not be the reason for this decrease. Neither has there been such a dramatic decrease in the number of NSF awards received by our two institutions over the same period. Our research did not collect data on the motivations of researchers, and whether there were any broad trends among researchers that might explain why fewer deposits were being made. Under the terms of the 2016 mandate, the NSF does not impose any consequences on authors or researchers for failing to deposit the mandated PDF into the repository, so it is possible that lack of consequence plays a factor in the declining rates of compliance. Agency policies responding to the 2022 OSTP memo are expected in 2024, so it remains to be seen whether funding consequences for non-compliance change the rate of deposit for NSF researchers.

Authors that did deposit work in the PAR (42% of the papers included in this study) uploaded their works in a wide range of formats, ranging from author manuscript versions, to published version PDFs, and even links to Google Drive files. The presence of final published versions of articles in the PAR when the publisher in question typically holds copyright over a paper indicates that copyright instruction or mediation would be beneficial at some point in the submission process. However, a majority (58%) of the articles included in our study did not have a repository document at all, rather the PAR record linked out to the publisher version of record. Unfortunately, the provided publisher link directed the user to a paywalled version in 45% of records. Users would then need to navigate back to PAR to try to discover a deposited version. Alternatively, in 24% of records, where there was no deposited version available, there would be a public access CHORUS version available at the publisher link, if the user knew the term and navigation process. This reliance on specialized terminology and process knowledge rather than direct links makes the public access versions more difficult to find, even when they are technically available. In these cases, the practice of relying on or fore-fronting a link to the publisher's version does not satisfy the spirit or intent of the public access policy, which is to promote availability of research to the public.

The authors did notice that often when a study was co-funded by the NIH, a public access version was openly available in PubMedCentral (PMC), even when no version was found in the NSF's PAR. Keeping track of the different processes for different funding agencies is a daunting task even for experts, so the authors speculate that when a paper was deposited in PMC rather than the PAR, it could be because authors might believe that deposit in PMC and compliance with the NIH policy satisfies the compliance requirements for NSF. It is not clear whether deposit of an article in PMC would technically be in compliance with NSF policy and guidelines, since the NSF policy makes no mention of PMC.

Open access policies take effort and resources to implement, and in the case of the policies resulting from the OSTP memo(s), the policies are not supported with any additional dedicated funding to the NSF (Holdren, 2013). A closer administrative oversight of the NSF public access policy could improve aspects of the process such as encouraging more authors to upload a manuscript version of their paper directly to PAR, educating authors about the nuances between a manuscript version and a final version, and providing information about CHORUS and CHORUS-enabled access to articles. Compliance must also be driven by more than just a mandate for authors to comply. Addressing these repository challenges are familiar to the academic librarian (Salo, 2007; Asadi et al., 2019; Joo et al., 2019). The authors imagine that the NSF, while an institute of significantly larger scale than most academic libraries, must face similar challenges of resource allocation, maintenance challenges, and a capability to increase the rate of compliance. The authors are not optimistic that the NSF will be provided with funding dedicated to the PAR, nor the resources to devote more people and time to overseeing this open access policy on its own. Therefore, if the NSF sees CHORUS as a viable route to compliance with this policy, the NSF should work with CHORUS to make sure CHORUS publishers make the public version the first option that the users encounter when redirected from the PAR.

It is worth noting that this study only looked at records that had already been submitted into the PAR. The authors have not investigated whether there are NSF-funded articles that never made it into the PAR in the first place. Further research into this topic could expand the scope to look at articles that were funded by NSF during a set period but were not reflected in the PAR.

## CONCLUSION

For the two institutes studied over the given time period, the NSF-PAR is under-compliant in terms of the 2013 OSTP memo. The authors anticipate that this trend will continue unless other action is taken. Currently the repository is not functioning like a repository. Rather, the PAR is functioning as a directory, relying on publisher-controlled access and link outs. At best, the link outs to open access versions at the publisher site, provided by CHORUS, are often not

as prominent as they could be, and at worst they obstruct the user from easily finding the open version. Providing access in this manner does not meet the NSF's own public access requirements for a PDF copy within its own repository. To reiterate, in the NSF's own language from 2015, "[The] NSF will require awardee institutions to ensure that authors of articles and papers that fall within the scope of this plan (as defined in Section 2.0) **deposit** copies of the author's final accepted peer-reviewed manuscript or the version of record in the **PDF/A** standard" (emphasis ours) (NSF, 2015, p. 11). The NSF reemphasized this language in 2023: "Beginning with new awards starting January 2016, NSF-funded researchers have been required to **deposit** publications stemming from funded research in NSF-PAR **as PDFs**" (emphasis ours) (NSF, 2023, p. 5). Additionally, publishers that hide or otherwise obfuscate the CHORUS link are subverting the intention of public access. The NSF includes a caveat about the CHORUS initiative in its Frequently Asked Questions (FAQs) for Public Access:

29. I am publishing an article in an Open Access Journal that is a member of the publisher coalition CHORUS. Do I still have to deposit a copy of the article in NSF-PAR?

Yes. You must deposit a copy of any peer-reviewed journal publication (either the final accepted version or the version of record) or any juried conference paper in NSF-PAR for articles (eligible publications or conference papers) resulting from an award made for a proposal submitted, or due, on or after January 25, 2016, even if the article was published in an Open Access journal that is a member of CHORUS ... (NSF, 2018).

It is important to note that this study only included items that already have records in the PAR—not items that should have PAR records but do not. The addition of language in the above quote from 2023 requiring awardee institutions to ensure compliance is telling: the NSF is aware of non-compliance, and as late as 2021, the director of the NSF issued an Important Notice to Presidents of Universities and Colleges and Heads of Other National Science Foundation Grantee Organizations, "requesting your assistance in improving your institution's compliance with NSF project reporting requirements" (Panchanathan, 2021, para. 1). Further research is needed to develop a clearer picture of how often NSF-funded researchers comply with federal mandates, and how the NSF will aim to provide the access mandated under the Nelson Memo.

For librarians, who are typically the open access advocates at their institutions, knowledge of how well the current federal policies are or are not working is crucial. Librarians often must awkwardly negotiate the fine line between promoting public openness to scholars and authors while simultaneously navigating the legacy publishing system (Dawson, 2018). To better

support scholars in finding and sharing research, it is imperative that librarians understand the real, practical effects of the implementation of federal open access policy.

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## DATA AVAILABILITY STATEMENT

Dataset reference: Powell, K., Rascoe, F., & Townes, J. (2023). NSF Public Access Repository (PAR) Publication Access Project Data Sharing (Version 1). figshare. <https://doi.org/10.6084/m9.figshare.24881763.v1>

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