Recommendations from the RISRS Report: Reducing the Inadvertent Spread of Retracted Science

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Research

Keywords: retraction, publication ethics, citation, spread of retracted research, citation of retracted research

Posted Date: August 5th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-783543/v1

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Recommendations from the RISRS Report:

Reducing the Inadvertent Spread of Retracted Science

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Abstract

Background: Retraction is a mechanism for alerting readers to unreliable material, effectively removing from the published scientific and scholarly record articles that are deemed to be seriously flawed. Research over the past decade has identified a number of factors contributing to the unintentional spread of retracted research. The goal of the Reducing the Inadvertent Spread of Retracted Science: Shaping a Research and Implementation Agenda (RISRS) project is to develop an actionable agenda for reducing the inadvertent spread of retracted science.

This includes identifying how the gatekeepers of scientific publications can monitor and disseminate retraction status and determining what other actions are feasible and relevant.

Methods: These recommendations were developed as part of a year-long process that included an exploratory environment scan, a scoping review of empirical literature, and successive
rounds of stakeholder consultation, culminating in a three-part online workshop that brought
together a diverse body of 70 stakeholders in October-November 2020 to engage in
collaborative problem solving and dialogue. Workshop discussions were seeded by materials
derived from stakeholder interviews (N=47) and short original discussion pieces contributed by
stakeholders. The online workshop resulted in a set of recommendations to address the
complexities of retracted research throughout the scholarly communications ecosystem.

Results: The RISRS recommendations are:

1. Develop a systematic cross-industry approach to ensure the public availability of
   consistent, standardized, interoperable, and timely information about rejections.

2. Recommend a taxonomy of retraction categories/classifications and corresponding
   retraction metadata that can be adopted by all stakeholders.

3. Develop best practices for coordinating the retraction process to enable timely, fair,
   unbiased outcomes.

4. Educate stakeholders about publication correction processes including retraction and
   about pre- and post-publication stewardship of the scholarly record.

Conclusions:
The continued circulation of retracted research is an ecosystem problem. These
recommendations focus on areas where stakeholders can collaborate to address the continued
citation of retracted research. We have suggested particular actions for standards organizations,
publishers, researchers, and research integrity organizations.
Keywords: retraction, publication ethics, citation, spread of retracted research, citation of retracted research
Retraction is a mechanism for alerting readers to unreliable material, effectively removing from the published scientific and scholarly record articles that are deemed to be seriously flawed whether due to misconduct or honest error. As noted in the Committee on Publication Ethics (COPE) Retraction Guidelines, retractions may also be used to address, “redundant publication, plagiarism, peer review manipulation, reuse of material or data without authorisation, copyright infringement or some other legal issue (e.g., libel, privacy, illegality), unethical research, and/or a failure to disclose a major competing interest that would have unduly influenced interpretations or recommendations” (1).

Research over the past decade has identified a number of factors contributing to the unintentional spread of retracted research. Many retracted papers are not marked as retracted on publisher and aggregator sites (2,3), and retracted articles may still be found in readers’ electronic libraries, including in reference management systems such as Zotero, EndNote, and Mendeley (4). Most publishers do not systematically surveil bibliographies of submitted manuscripts, and most editors do not query whether a citation to a retracted paper is justified. When citing retracted papers, authors frequently do not indicate retraction status in bibliographies or in-text citations.

A study of citations to retracted papers in PubMed found that only 5.4% of post-retraction citations acknowledged that the paper they were citing was retracted (5). A smaller study, focused on two retracted COVID-19 articles, found that 52.5% of citations did not acknowledge the fact that they were retracted despite the widespread media attention that these retractions received (6). In addition to spreading information without notifying readers that the source was
retracted, the citation of retracted papers can also impact the validity of the paper that is citing it, including meta-analyses that include retracted papers (7).

The goal of the Reducing the Inadvertent Spread of Retracted Science: Shaping a Research and Implementation Agenda (RISRS) project is to develop an actionable agenda for reducing the inadvertent spread of retracted science. This includes identifying how the gatekeepers of scientific publications can monitor and disseminate retraction status and determining what other actions are feasible and relevant.

Methods

The RISRS project has derived recommendations through a cross-sectoral consultation process. This year-long process included an exploratory environment scan, a scoping review of empirical literature¹, and successive rounds of stakeholder consultation², culminating in a three-part online workshop (October 26, November 9, and November 16, 2020) that brought together a diverse body of 70 stakeholders to engage in collaborative problem solving and dialogue. Workshop discussions were seeded by materials derived from stakeholder interviews (N=47) and short original discussion pieces contributed by stakeholders. The online workshop resulted in a set of recommendations to address the complexities of retracted research throughout the scholarly communications ecosystem. The team iteratively updated and developed recommendations through a series of surveys and drafts.

¹ See Appendix C: Literature Scoping Review Methods and Intermediate Results in (8) and the online bibliography https://infoqualitylab.org/projects/risrs2020/bibliography/
² See Appendix D: Stakeholder Consultation Process in (8). Workshop attendees are also listed on the project website: https://infoqualitylab.org/projects/risrs2020/attendees
Given the repeated attention to citation of retracted papers since the 1990’s, we knew that the inadvertent spread of retracted science was a complicated and long-standing issue. We started from the assumption that this was a “stuck” problem that would require collaboration across diverse stakeholders and, possibly, systemic changes to the way people work across scholarly communication.

We conceptualize scholarly communications as an ecosystem comprising the individuals, institutions, and processes through which research is produced, packaged, managed, disseminated, promoted, consumed, and preserved into something deemed the scholarly record. Examples of individuals include publishers, editors, researchers, librarians, standards developers, funding program officers, and technologists. Examples of institutions include universities, government labs, funding bodies, publishing houses, libraries, technology companies, standards organizations, infrastructure providers, and vendors. Examples of processes include: submitting, peer reviewing, or accepting a manuscript; quality assurance; typesetting; creating metadata; depositing data; curating research products; selling, licensing, and acquiring books, journals, etc. These are embedded in material, social, and technical processes, which we conceptualized as points of intervention. By working with stakeholders from across the ecosystem, we endeavored to understand how people interact with retracted research, and encouraged stakeholders to reflect on how these interactions could be redesigned to interrupt the continued citation of retracted research in these chains of research communications.
Scope

This report focuses on the continued citation and use of retracted research, where our scope is primarily, but not exclusively, the continued citation and use of retracted research. Our investigation at times strayed beyond citation and use alone. That is because, for many of the sources and people we consulted, citation and use are intertwined with a much broader frame of reference, including the goals, purpose, and meaning of retraction, and expectations regarding its implementation, and other aspects.

Part of the work of this project has been to move from the widespread view of retraction as a social problem to a common stakeholder agenda specifying the range of problems associated with retracted research and its continued citation. Collaboration across major stakeholder groups is challenged by lack of common agreement about the scope of the problem, or the efficacy of strategies to address the issue. For example, retracted research is sometimes framed as an issue of individual misconduct or accountability. Likewise the continued citation of retracted research may be framed in terms of breakdowns in editing and publishing processes. Such differences in aim and perspective lead to some tension about what is needed, and what is possible. On the one hand, many interviewees called for substantive reform of the scientific publishing ecosystem itself and its role in scientific careers. On the other hand, other interviewees called for fine-tuning of current practices and processes in effect to optimize the retraction process, and clarify the role of retraction in stewarding the scientific record. This unresolved tension has limited efforts to build the will and capacity to address the continued spread of retracted research.

Mitigating the effects of the continued spread of retracted research will require multiple types of coordinated interventions. Multiple stakeholder communities and multiple areas of the scholarly
communications ecosystem are involved, and stakeholder groups are impacted by retracted
research in differing ways. As many interviewees suggested, disseminating and adopting
existing best practices will go a long way. Our review of the literature and interviews with
stakeholders also identified some innovation problems that will require the development of new
standards, policies, or norms. However, incentivizing change and building the will to address
recognized issues is a persistent system-level issue in scholarly communication.

Results

These recommendations refer to cross-sectoral areas where action can be taken to address
retracted research and its continued citation. Rather than target a particular sector, or problem,
the recommendations below speak to multiple points in the scholarly communications
ecosystem. We prioritize recommendations for which there exists momentum to address the
issue, known examples that can be used to model standards or best practices, current
technologies that can be adopted, and proposals for which there is existing or strong
agreement.

1. Develop a Systematic Cross-industry Approach to Ensure the Public Availability of
Consistent, Standardized, Interoperable, and Timely Information about Retractions.

Over 94% of post-retraction citations in biomedicine do not demonstrate awareness that the
cited item was retracted (5). Users' typical citation workflows may involve citing preprints,
reusing downloaded copies, citing older works contained in their reference managers, and
copying citations from their own or others' previous bibliographies (4,17). Among citation styles,
only the American Medical Association (18), National Library of Medicine (19), and American
Psychological Association (20) styles provide explicit standards for citing retracted papers³

³ See Appendix E: Existing Citation Standards for Retracted Publications (8).
Among commonly used systems, only a handful of databases (such as PubMed and RetractionWatch) and tools built on them (such as Zotero and scite) ensure that users know that a paper they are citing is retracted.

Information about retraction needs to move across different industry information providers (publishers, abstracting and indexing services, scholarly search engines, etc.). However, currently this need is challenged by non-robust dissemination, inconsistent information, and inconsistent presentation of retraction status information (21–24).

Shared standards amongst publishers are necessary, but currently there are no industry-wide standards for retraction information or its visibility. The most widely accepted guidelines, from the Committee on Publication Ethics (COPE) (1) and the International Committee of Medical Journal Editors (ICMJE) (25), recommend how to make retraction information easy to use and find. However, they are not uniformly adopted. Although both are widely accepted by many publishing groups, particularly in medicine (26,27), previous research has found that publishers do not uniformly adhere to COPE and ICMJE recommendations (28–30) and that more consistent display standards are needed, particularly regarding uniformity in landing pages (22).

In 2015, Retraction Watch also published its own standard for what a retraction notice should include, with more details than those of COPE and ICMJE (31).

Supporting and motivating stakeholders to consistently adopt and follow COPE and ICMJE recommendations for managing retracted articles and retraction notices is a baseline for further improvements. Beyond COPE and ICMJE recommendations, publishers should update procedures to add ‘Retracted’ to the titles of retracted articles.
A standards group should develop best practices for databases that facilitate the public and unrestricted access to and dissemination of retraction statuses and retraction notices. Processes, model license agreements, and standards for retraction data interchange are needed to facilitate information flow between publishers, aggregators, and database providers. Model license agreements could expand on established agreements such as the National Library of Medicine's participation agreement for deposit (32).

Sustainable funding sources are urgently needed for databases to facilitate the public and unrestricted access to and dissemination of retraction notices. At minimum, such databases should feature automated electronic means of data retrieval (e.g., Application Programming Interfaces (APIs)) to track and disseminate retraction statuses. Currently, the Retraction Watch Database is a licensable source of good quality, domain-independent data about retracted papers.

A standards group should convene a working group composed of reference and citation industry groups along with members from COPE, the National Information Standards Organization (NISO) etc. The working group should be charged with defining best practices addressing retraction and post publication amendments in citation styles and citation software; developing additional citation styles and standards for indicating the retraction or correction status of a paper in text and in a bibliography.

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4 The difference between restricted access and unrestricted access, facilitated by funding, can be seen by comparing the Retraction Watch Database to PubMed. Retraction Watch is a public database with restricted access. Free public results are limited to 600 and license agreements are required for bulk use. Its funding has included grants, private donations, and licensing agreements. PubMed is a public database, free to users (completely funded by the United States government), with unrestricted access to and dissemination of retraction notices, but only in biomedicine. PubMed has an API but as of July 2021 the Retraction Watch Database does not.
Multiple stakeholders can play a part in adoption. Citation software developers should add features to flag retracted papers in their tools (e.g., EndNote, Mendeley, Paperpile, RefWorks, etc.); Zotero, which flags retracted papers based on DOIs in Retraction Watch Database data can be used as a model. Researchers should use citation software that flags retracted papers. Submission management platforms should integrate tools that enable systematic identification of retracted articles. Publishers should adopt software solutions that enable systematic identification of retracted articles in bibliographies prior to publication and check bibliographies for retracted paper as part of manuscript review and publishing workflows. Publishers should also invest in maintaining metadata, including promptly registering post-publication amendments with Crossmark (33), which became free to Crossref members in March 2020 (34).

2. Recommend a Taxonomy of Retraction Categories/Classifications and Corresponding Retraction Metadata that can be Adopted by All Stakeholders.

Retraction notices often provide vague or limited information about the reasons for retraction (28,35,36). People using retracted science and evaluating authors of retracted science demand additional context about retraction to both clean up the literature and disincentivize misconduct (37). Concerns about possible reputational damage and the risk of litigation can disincentivize the use of more fine-grained distinctions about reasons for retraction (38).

A working group composed of standards organizations, publishers, and metadata development organizations should work to develop a taxonomy of retraction categories and corresponding metadata standards in tandem. In order to ensure the taxonomy is viable over the long-term, it should be curated and maintained on a discoverable website with a formal home and be based in an industry standards organization such as the NISO or the International Association of Scientific, Technical and Medical Publishers (STM). The taxonomy should be integrated with existing versioning systems and include recommendations for how database records for
retraction should include the taxonomy term for when a retraction reason is implemented and adopted by journals. Finally, to ensure adoption, we recommend that highly visible organizations build support and influence through endorsement and adoption of the taxonomy and metadata standards, in order to support and motivate other stakeholders to adopt them.

Publishers, standards organizations, platforms, and infrastructure providers should collaborate to develop and support the use of persistent identifiers throughout the publishing ecosystem to enable audit-like functions to track amendments (39). To do this we suggest building off of the F1000 model, in which: “All versions of an article are accessible, each with their own DOI (digital object identifier) and may be cited individually. The most recent article version is displayed as the default, and older article versions display a clear notification that newer versions are available” (40).


The time between the publication of papers and their potential amendment or retraction is a period in which papers may be adopted, used, and woven into the tapestry of scholarship. This time has been as long as 45 years (PMID:1233443), but papers retracted quickly may also receive fewer post-retraction citations (5). Reducing the time to retraction is desirable to ensure the clear and timely communication of amendments to publications. Another danger is that compromised research is identified but fails to be retracted because of logistical complexity amongst all stakeholders involved in the retraction process. In these cases, failure to retract enables the continued citation of research that should have been retracted.

Existing guidelines acknowledge the problems related to time to retraction. For example, the COPE 2019 guidelines say: “Publications should be retracted as soon as possible after the
editor is convinced that the publication is seriously flawed, misleading, or falls into any of the
categories described above." However, stakeholders suggest that coordination amongst
authors, co-authors, editors, and in some cases institutions may present complex logistical
problems or conflicts of interest. For example, review of compromised figures, data sets, and
data represented in images can be costly and time consuming. For editors and publishers, the
COPE flowchart library is in common use, and could be a model for developing workflow models
and suggestions aimed at a variety of additional stakeholders. Some interviewees and
workshop participants suggested that efforts to innovate retraction processes in this nexus—
between institutions, publishers/editors, funders and researchers/editors—are often hampered
by perceptions of risk and liability. Early adopters of reforms potentially face increased risks
(e.g., liability) on top of the cost of developing policies and procedures; potential costs include
referral boards or independent investigative bodies.

Here, we recommend the use of the Cooperation & Liaison between Universities & Editors
(CLUE) report (41) recommendations to develop best practice guidelines to streamline the
retraction process with respect to institutions and sponsoring agencies by improving
coordination between institutions, publishers, funders and researchers. Additionally, COPE and
the research integrity groups such as the Association of Research Integrity Officers (ARIO) and
the European Network of Research Integrity Offices (ENRIO), should work to clarify best
practices and guidelines for journals, authors, and institutions to efficiently coordinate and
address concerns about published work. This should include offering fast-tracks for retraction
notices to move through the process more quickly, if the authors agree with or request
retraction, or if a retraction is requested following an institutional misconduct investigation. Here,
publishers should reserve the right to retract in legal agreements with authors. Publishers
should also make sure that all journal websites provide clear instructions on how to submit an
inquiry or concern about possible research misconduct or serious error. For instance, websites
may not have updated contact information or email addresses. Finally we suggest creating a workflow template for starting a retraction inquiry and adopt a checklist of requisite information for a retraction notice. Publishers and editorial societies should encourage journal editors and institutions to develop systematic processes, including templates and checklists to coordinate and communicate about the retraction inquiry.

4. Educate Stakeholders About Publication Correction Processes including Retraction and about Pre- and Post-Publication Stewardship of the Scholarly Record.

Stakeholder education can help researchers and editors understand the range of post-publication corrections. Retraction is a publishing mechanism for cleaning up the literature, and not does not signify misconduct. Currently stakeholders report a tension between the need to correct the literature and the need to preserve their reputations, either as researchers or as editors. Fear of stigma or career impacts can make researchers reluctant to participate in retraction processes, even to correct honest mistakes or errors. Fear of litigation makes editors reluctant to initiate retraction inquiries (1,42). Awareness of retraction and the reasons for retracting research may vary by field; this contributes to a confusion about the severity and impacts of retraction. Professional, disciplinary and scholarly societies, publishing associations and editorial groups, government agencies, and local institutional programming should develop education aimed at researchers, authors and editors.

Researcher Education

Researcher education should focus on the value of amending the published literature, including through retraction. Suggested topics for Responsible Conduct of Research education should include publication ethics, including peer review and retraction. Disciplinary and scholarly societies should develop discipline-specific materials as well. These education initiatives should
emphasize the need to correct publications as part of responsible data management and work
to destigmatize the act of retracting articles.

One strategy for doing this would be to develop an anthology of stories of honest retraction
aimed at destigmatizing retraction amongst senior scientists, following the examples of The
Winower (43,44) and Retraction Watch’s Doing the Right Thing series (45). Additionally,
stories can give researchers a platform to express concerns they have with their own work,
whether the issues might warrant retraction or other types of post-publication amendment,
following the example of the Loss-of-Confidence Project in psychology (46). In general, we
recommend moving away from inflammatory language associated with misconduct by
naturalizing a more neutral tone for retraction inquiry and reportage. To broaden reach, we
suggest developing pedagogical materials for use in broader ethics and professionalization
training. Materials should be made available in open education platforms under licenses suitable
for translation and reuse, to encourage multilingual availability. This should include materials on
different reasons for post-publication changes to publications.

Author Education

Publishers, librarians, and disciplinary, professional, and scholarly societies should work to
educate authors about their responsibilities related to retraction and other post-publication
amendments (e.g., letters to the editor, corrections, and expressions of concern). Authors have
a responsibility to evaluate and assess the references in their bibliographies. In particular,
before publication, authors are expected to cite and reference reliable papers in good standing.
In cases where it is relevant to discuss retracted work, both the article/text and bibliography
should clearly indicate the retracted status of the cited work. Before publication, authors are
expected to provide correct and complete reference details, and, in the pre-press stage, to
respond to questions about errors/omissions in manuscript bibliographies. After publication,
authors of evidence synthesis products are expected to notify the journal if they notice that an article they cited has been retracted, because as COPE notes, “Articles that relied on subsequently retracted articles in reaching their own conclusions, such as systematic reviews or meta-analyses, may themselves need to be corrected or retracted” (1). Amendments provided by previous authors (e.g., 47–49) can be used as examples. Authors should take action to amend or retract their own research if compromised. If issues with an article come to light post-publication, an author should notify the publisher, their own institution, and all co-authors’ institutions.

Editor Education

General editorial education should build awareness of existing COPE resources and retraction best practices among editors, peer reviewers, and publishers. Publication ethics training modules and case studies should particularly target under-resourced groups, such as small museum and library-based scholarly publishers, by developing modules for education platforms, including Educopia’s Library Publishing Curriculum (50).

Editorial societies should develop and disseminate best practice educational modules that address the stigma associated with retraction. Editors, peer reviewers, and publishers should encounter examples of honest inadvertent serious errors that have required retraction. Editors should be incentivized to destigmatize the decision to retract articles. Education modules should provide support for editors developing or updating policies. Best practices for publicity and knowledge maintenance should also be developed; for example, Anesthesiology’s “what do we still know” series provides a model (51,52) for topic editors, journal editors and others responsible for stewarding research on a topic to commission review articles to revisit the
entirety of research on a topic, in the wake of a series of retractions or other post-publication amendments.

Standards groups should form working groups to develop best practices for emerging concerns. A working group on preprint publication ethics should be charged to update and build momentum on recommendations for preprint servers (including withdrawal and removal of preprints) (53), developed at the January 2020 ASAPbio, EMBL-EBI, and Ithaka S+R meeting. A working group on authoritative sources of retraction information should be charged with supporting authors in identifying authoritative sources for checking citations beyond Retraction Watch and PubMed.\textsuperscript{5}

Discussion

Prioritization

We suggest stakeholders prioritize the first two recommendations, #1 Develop a systematic cross-industry approach to ensure the public availability of consistent, standardized, interoperable, and timely information about retractions, and #2 Develop taxonomy of retraction categories/classification and corresponding retraction metadata that can be adopted by all stakeholders. First, the remaining recommendations will have more traction once some agreement around Recommendations #1 and #2 has developed. Second, some progress on these recommendations has already been made.

\textsuperscript{5} Outside of medicine, we are not aware of statements about authoritative sources of retractions, analogous to that given in the ICMJE guidelines: “For articles published in journals indexed in MEDLINE, the ICMJE considers PubMed the authoritative source for information about retractions” (25).
NISO has convened meetings to consider developing a recommended practice or a standard for how retractions/withdrawals should be handled by publishers, as a follow up from a RISRS cross-industry panel at NISO Plus 2021. We expect NISO standardization work, if taken up, to follow up on Recommendations #1 and/or #2.

There was broad stakeholder agreement during the workshop that a taxonomy and metadata (Recommendation #2) was a necessary first step, and a COPE working group has already produced an initial draft of the taxonomy, described by Deborah Poff at the Society for Scholarly Publishing 2021 conference (54). The next step will be for multiple stakeholders to assess the taxonomy, document what works, iterate as necessary, and encourage adoption. NISO or another standards body may be an appropriate long-term steward for this taxonomy.

The goal of the RISRS project has been to clarify the scope and dimensions of the problem of continued citation of retracted research, and to develop a research and implementation agenda for reducing its spread. In this conclusion, we briefly cover some aspects of our implementation strategy, and describe ways for you to contribute to the collaborative development of this agenda.

Our general approach to this problem has been to co-develop a set of actionable recommendations with a diverse group of stakeholders associated with scholarly communications. To do this, we initiated a scoping literature review and created multiple opportunities for sustained stakeholder consultation. Both enabled a process of problem definition and refinement where we actively worked with stakeholders to identify viable areas on which to focus our attention, and to anchor recommendations in the terrain of the scholarly communications ecosystem.
Implementation Strategy

We have outlined possible cross-sectoral strategies for introducing change throughout the scholarly communications ecosystem, and hope that this encourages collaboration amongst stakeholders from different industries to address the continued citation and use of retracted research.

Our aim is for stakeholders to take up our recommendations as elements of an implementation agenda that targets reducing the continued citation and use of retracted research. We have prioritized recommendations that are immediately and practically actionable, and which will support robust collaboration between stakeholders utilizing existing practices, policies, standards and technologies.

Conclusion

Addressing the inadvertent, continued citation of retracted science will require iterative work from many parts of the scholarly communications ecosystem. Early implementation activity coming out of the RISRS process has resulted in some promising initiatives that look at how to develop these recommendations in ways that will meaningfully address long-standing issues in the scholarly communications ecosystem that contribute to the continued citation of retracted materials. The COPE taxonomy working group and the proposed NISO work item are helping to address this issue by advocating for stakeholders to address the interlinked issues, but also innovating practical solutions to be further co-developed in specific sectors of the scholarly communications enterprise.
Yet there is still more work to be done, and we hope that by synthesizing this material we not
only further the conversation about how to best address the problems presented by the
continued circulation of retracted research, but as well support stakeholders in developing
practical and actionable strategies within their zone of influence. It is our hope that further
working groups take up the recommendations outlined above, as well as some of the targeted
implementation priorities that we highlight.

A Call to Implement and Collaborate

We encourage you to disseminate these recommendations and to envision how you, in your
role, and in collaborative partnerships, can make a difference. Additionally, the full RISRS report
(8) details several other implementation actions, related to the general recommendations, as
well as a corresponding research agenda.

Feel free to involve RISRS participants and the authors of this document in implementation
actions to enact this vision! We welcome suggestions for ongoing research and collaboration,
via the project website https://infoqualitylab.org/projects/risrs2020/ or by email to
jodi@illinois.edu.

List of abbreviations

ARIO: Association of Research Integrity Officers
COPE: Committee on Publication Ethics
ENRIO: European Network of Research Integrity Offices
ICMJE: International Committee of Medical Journal Editors
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Declarations
Ethics approval and consent to participate

The project was approved by the Institutional Review Board at the University of Illinois, Urbana-Champaign. All participants provided consent for participation.

Consent for publication

Participants provided consent for participation, for use and publication of anonymized direct quotes, and for dissemination of the findings from this project. For this publication, participant input was provided in the development of the recommendations, but direct quotes from participants were not used.

Availability of data and materials

The full RISRS report informing this publication is available on MetaArXiv Preprints (CITE). Many project outcomes are in IDEALS, the UIUC institutional repository, in the RISRS Collection https://www.ideals.illinois.edu/handle/2142/108359 and on the RISRS project website https://infoqualitylab.org/projects/risrs2020/

Data: We have deposited the qualitative analysis of materials used in the RISRS report in the UIUC Databank (Woods, 2021). Given the risk of identification, we are unable to share full transcripts of the interview data.

Competing interests

Jodi Schneider has been an invited speaker for the publisher organization CrossRef and has received data-in-kind from Retraction Watch and scite.
Funding

The project “Reducing the Inadvertent Spread of Retracted Science: Shaping a Research and Implementation Agenda” was supported by Alfred P. Sloan Foundation G-2020-12623.

Authors’ contributions

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Contributions

**Yoss Arianlou:** Investigation; **Yee Yan ‘Vivien’ Yip:** Investigation; **Halle Burns:** Investigation;

**Mary Terese Campbell:** Project administration; **Yuanxi Fu:** Investigation; **Katherine Howell:** Investigation; **Tzu-Kun (Esther) Hsiao:** Investigation; **Randi Proescholdt:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing; **Jodi Schneider:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing; **Nathan D. Woods:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing.

Acknowledgements

This work was made possible by the participation of our interviewees and workshop attendees. We gratefully acknowledge their contributions and feedback. Thank you to the wider community who joined in providing post-workshop feedback on many of the project outcomes, including Alison Avenell, Jennifer Byrne, Renee Hoch, Hervé Maisonneuve, and Iraxte Puebla.
The RISRS Team: Halle Burns, Jodi Schneider, Katherine Howell, MT Campbell, Nathan D. Woods, Randi Proescholdt, Tzu-Kun (Esther) Hsiao, Yee Yan ‘Vivien’ Yip, Yuanxi Fu, Yoss Arianlou

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Jodi Schneider is Assistant Professor at the School of Information Sciences, University of Illinois at Urbana-Champaign where she runs the Information Quality Lab. She studies the science of science through the lens of arguments, evidence, and persuasion with a special interest in controversies in science. Her recent work has focused on topics such as systematic review automation, semantic publication, and the citation of retracted papers. Interdisciplinarity (PhD in Informatics, MS Library & Information Science, MA Mathematics; BA Great Books/liberal arts) is a fundamental principle of her work. She has held research positions across the U.S. as well as in Ireland, England, France, and Chile. She recently completed the NIH R01 Text Mining Pipeline to Accelerate Systematic Reviews in Evidence-Based Medicine with Aaron Cohen and Neil Smalheiser. She leads the Alfred P. Sloan-funded project, Reducing the Inadvertent Spread of Retracted Science: Shaping a Research and Implementation Agenda.

Nathan D. Woods is an interdisciplinary scholar, practicing anthropologist, and information professional working at the intersection of research and practice on issues related to the production, use, and stewardship of science, scholarship, and cultural memory. Working with multiple communities of practice, his larger research agenda considers the complex and dynamic relationships between knowledge, the design of institutions, and the organization of expert work. Ongoing projects explore the changing organization of scholarship; the science-policy interface; and the democratization of knowledge production. He holds a PhD in Anthropology from the CUNY Graduate Center; an MSLIS from the University of Illinois,
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