Reducing the Inadvertent Spread of Retracted Science: Shaping a Research and Implementation Agenda

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EXECUTIVE SUMMARY

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 unreliable or 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." (COPE Council, 2019). Retracted papers insinuate themselves into the scientific publication network via citations both before and after retraction, which inadvertently propagates potentially faked data, fundamental errors, and unreproducible results, or can lead to misattribution of results or ideas (e.g., in cases of retraction due to dual publication, plagiarism, or ownership). 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, and retracted articles may still be found in readers' PDF libraries, including in reference management systems such as Zotero, EndNote, and Mendeley. 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. Collaboration across diverse stakeholders in the academic publishing ecosystem is needed to reduce the inadvertent spread of retracted science. This is a critical moment for stakeholder dialogue: There is growing concern about the quality and reliability of scientific and scholarly information both within the research enterprise and in the broader public discourse; and the data needed to identify retracted research has become available, particularly from the Retraction Watch Database.

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. Herein the term, *paper*, is used for the published item that is retracted. We focus on whole, published items such as journal articles, conference papers, book chapters, and monographs. Except where otherwise stated, we exclude items that are posted as opposed to published such as preprints or data deposits as well as specific objects within a publication such as figures and images. The RISRS process included an exploratory environment scan, a scoping review of empirical literature, and successive rounds of stakeholder consultation, culminating in a 3-part online workshop 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 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 recommendations below are being circulated for further refinement (e.g., through the draft white paper you are now reading) with the aim of producing a final white paper in May 2021. The RISRS team will continue to solicit feedback from across the scholarly communications ecosystem, through presentations this spring to the Society for Scholarly Publishing and other groups. We welcome your feedback to refine the recommendations and the implementation agenda. For instance, you might help form a professional working group to further develop or refine these recommendations; present about retraction and related issues at professional and academic meetings; take on an implementation or policy project; or outline further research to be conducted.

Recommendations

1. Prevent retractions from polluting the literature through the public availability of high-quality, consistent information about retractions.

2. Make retraction information easy to find and use by using clear and consistent display standards.

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

4. Develop best practices for coordinating the retraction process.

5. Educate stakeholders about retraction and pre- and post-publication stewardship of the scholarly record.

INTRODUCTION

Retracted science is research that is withdrawn from the scientific and scholarly record. An article may be retracted due to the unreliability of the reported research or due to issues such as duplicate publication, plagiarism, unethical research, peer review manipulation, or use of data without permission. Although there is a growing public awareness of the harms associated with retracted science, the problem of retracted research and its continued citation is often framed in unhelpful ways as an intractable social problem, or as a deficiency of scientific authority or scientific institutions. Rather, retracted research is best understood in relation to complex problems involving the use and dissemination of research, as well as the coordination of resources and responsibilities across a number of stakeholders.

Retracted papers may be insinuated into the scientific publication network via citations both before and after retraction, which inadvertently propagates the reliance on articles that have been deemed as problematic. In many cases, this can lead to continued use or referencing of potentially faked data, fundamental errors, and unreproducible results. Between 2003 and 2009, hundreds of thousands of people were put at risk of life-threatening side effects from taking two blood pressure medications in combination, after a fraudulent trial reported that the combination was better than either drug alone (Naik, 2011; Steen, 2011). The retracted paper is still in the top 1% of most cited articles with 932 citations in Scopus as of January 2021. Its pre-retraction citations include a 1-page journal club summary published by a US top society for primary care physicians (Weise, 2003); despite being prominent in search engine results, the journal club page has not been updated to reflect the retraction. Post-retraction citation accounts for 18% (173) of the citations, including 59 reviews, and 30 articles in or after 2015. For instance, a 2014 Cochrane review (Li et al., 2014), which has been integrated into current UK and Australian clinical guidelines (National Heart Foundation of Australia & National Blood Pressure and Vascular Disease Advisory Committee, 2016; National Institute for Health and Care Excellence, 2019), uses the retracted paper's published data without mentioning its 2009 retraction (The Editors of The Lancet, 2009).

In another case, Dutch social psychologist Diederik Stapel was found to have fabricated data, resulting in 58 retracted papers (Palus, 2015). While the number of citations to Stapel's top 20 papers decreased after retraction, and even began to decrease prior to retraction due to media coverage, they were cited 102 times after their retraction, with the majority (78.4%) citing Stapel's research positively—that is, not referencing the fact that it was based on fraudulent data (Fernández & Vadillo, 2019).

A more recent example is illustrated by the significant role retracted research has played in the COVID-19 pandemic. In June, two top tier medical journals, the Lancet and the New England Journal of Medicine, made high profile retractions of COVID-19-related research published the previous month (Piller, 2021). Although both articles were retracted, they continue to have wide dissemination, with each receiving 981 and 816 citations, respectively, in Google Scholar as of March 2021. Science Magazine analyzed a sample of 200 papers, finding that over half of the citing papers did not mention the retraction; publishers and editors were "caught by surprise" and many do not systematically check for retraction or post-publication corrections (Piller,

2021). These examples demonstrate the urgency of organized efforts to limit the continued spread of retracted science, and to mitigate the outsized impact retracted research has on the public confidence in science, the use of scientific information in evidence-based decision-making and actions, and on the careers of researchers.

Although retraction is relatively rare, it has an outsized impact. The COVID-19 examples demonstrate the urgency of organized efforts to limit the continued spread of retracted science, and to mitigate the detriment retracted research has on public confidence in science, the use of scientific information in evidence-based decision-making and actions, and on the careers of researchers.

Research over the past decade has identified a number of disparate factors contributing to the unintentional spread of retracted research. Many retracted papers are not marked as retracted on publisher and aggregator sites and many post-retraction PDFs are not watermarked (Bakker & Riegelman, 2018); pre-retraction PDFs may be found in readers' PDF libraries including in reference management systems such as Zotero, EndNote, and Mendeley (Bar-Ilan & Halevi, 2018; Davis, 2012). Most publishers do not systematically surveil bibliographies of submitted manuscripts, even though technology is emerging (including scite.ai's Reference Check for manuscripts) and most editors do not query whether a citation to a retracted paper is justified (Piller, 2021). When citing retracted papers, authors are not required to identify retraction status in bibliographies or in-text citations. Current mitigators such as Crossmark "Check for updates" buttons (*Crossmark*, n.d.) and a Zotero retraction flagging system (Stillman, 2019) provide partial relief for individuals. In 2020, new tools for manuscript submission systems became available, particularly Reference Check from the startup scite, which checks bibliographies against data from Crossref and Retraction Watch during submission and review, so far integrated into Manuscript Manager, with integration coming in early 2021 for Aries (Editorial Manager) and Scholar One. A comprehensive solution requires interventions at multiple points (Davis, 2012), especially the involvement of publishers (Bar-Ilan & Halevi, 2017; Madlock-Brown & Eichmann, 2015).

RISRS Project Goals

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

Our inquiry was initially structured around the following questions:

1. What is the actual harm associated with retracted research?
2. What are the intervention points for stopping the spread of retraction? Which gatekeepers can intervene and/or disseminate retraction status?
3. What are the classes of retracted papers? (What classes of retracted papers can be considered citable, and in what context?)

4. What are the impediments to open access dissemination of retraction statuses and retraction notices?

To address these questions, the RISRS process included an exploratory environment scan, a scoping review of empirical literature, and successive rounds of stakeholder consultation, culminating in a 3-part online workshop fostering collaborative problem solving and dialogue among a diverse body of 70 stakeholders from research institutions, government agencies, funding bodies, publishing houses, libraries, technology companies, and vendors. Workshop discussions were seeded by materials derived from stakeholder interviews 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.

Framing the Problem

To reduce the inadvertent spread of retracted science, collaboration is needed across diverse stakeholders in the academic publishing ecosystem. Yet such 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.

There are a set of incommensurate priorities. At the first day of the RISRS workshop this arose as a set of contrasting imperatives: Are we trying to clean up the literature? Or… are we trying to reform science? Or… are we trying to reform science publishing? The importance of retraction as a means of "cleaning up the literature," stresses post-publication corrections of the scholarly record as a routine part of scientific progress. Alternately, retraction shows the urgency of the need and opportunity to reform science, with better research training, better methods, more transparency, and better ethical training to alleviate errors, *before* research is published.

Such differences in aim and perspective lead to some tension about what is needed, and what is possible. On the one hand, many call for substantive reform of the scientific publishing ecosystem itself and its role in scientific careers. On the other hand, others call for fine-tuning 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 limits efforts to build the will and capacity to address the outsized impact of retracted research.

An additional challenge is that proposed solutions to the problems posed by retractions are often pitched in terms of one sector, workflow, or sphere of responsibility. To the extent that solutions are developed, they are often introduced in sector-specific ways. The RISRS team believes that increasing contact between stakeholders can help identify areas where collaboration is necessary and could be effective, in part by increasing stakeholders' familiarity with each others' work contexts.

The recommendations and plans in this document will ultimately become a resource for aligning sector-specific problem-solving with cross-sectoral collaborations or partnerships. Ultimately, the implementation agenda will present a comprehensive map of possible implementation pathways. Likewise, the research agenda will point to priority areas for future research.

Call to Action

The recommendations below are being circulated for further refinement (e.g. through the draft white paper you are now reading) with the aim of producing a final white paper in May 2021. The RISRS team will continue to solicit feedback from across the scholarly communications ecosystem through presentations this spring to the Society for Scholarly Publishing and other groups.

We welcome your feedback to refine the recommendations and the implementation and research agenda. For instance, you might help form a professional working group to further develop or refine these recommendations; present about retraction and related issues at professional and academic meetings; take on an implementation or policy project; or outline further research to be conducted. Based on your feedback we will continue to engage in the work of synthesis as we add to or refine recommendations.

The proposed schedule for ongoing feedback is:

Mar 14 Version 2 circulated to stakeholders
Mar 29 Deadline for comments, suggestions

Apr 12 Version 3 circulated to stakeholders for last look
Apr 26 Deadline for comments, suggestions

May 3 White Paper completed

We invite you to provide additional feedback to help shape the scope of the recommendations. This version is being circulated publicly as a preprint to maximize the feedback we receive. We would appreciate feedback in the Google Docs linked from the project website https://infoqualitylab.org/projects/risrs2020/ or by email to jodi@illinois.edu.

THE RISRS PROCESS

The RISRS project has derived recommendations through a cross-sectoral consultation process. This section describes the process itself.

Stakeholders came from research institutions, government agencies, funding bodies, publishing houses, journals, libraries, technology companies, research infrastructure organizations, and vendors. By building up a body of engaged stakeholders, this project has worked to create opportunities to bridge the gaps between differing stakeholder perspectives, looking beyond the

published literature to understand how the problem of retracted science and its continued citation is understood in multiple, often divergent, stakeholder contexts. These ongoing efforts at synthesis culminated in a 3-part online workshop. The workshop built upon a series of discussions resulting in a set of ecosystem scale recommendations. Post-workshop activities will disseminate the RISRS draft recommendations widely throughout the scholarly communications industry, to integrate these recommendations into an implementation and research agenda, and to enlarge participation among a wider group of stakeholders.

Scoping Literature Review

The scoping review was designed to systematically identify the literature on retraction, identify what we know about retraction from the empirical research literature, and to clarify what has been studied, and how it has been studied. We are particularly interested in understanding inconsistencies in methods, topics and assumptions across the body of literature.

To identify articles, we formally searched the literature in July 2019 and again in April of 2020, using a combination of systematic search in the PubMed, Scopus, and Web of Science databases and a text and citation update tool we developed for Scopus (Sarol et al., 2018)(see Appendix: Search Strategy). We supplemented these formal searches with a database of materials we had collected ad-hoc during 2017-2019. We iteratively developed inclusion criteria (See Appendix: Inclusion Criteria), focusing on identifying empirical research related to retraction.

Following our screening, to date, we have identified 162 central papers. We have shared this bibliography to enable its wider use, especially given the wide dispersion of this literature across multiple disciplines and diverse publication venues. (See https://infoqualitylab.org/projects/risrs2020/bibliography/). All of our preliminary synthesis in the Literature Review and Current Awareness section below draws almost exclusively on this set of 162 articles. There are several limitations to this set. First, so far the review has processed only the most central articles: Our count of 162 omits 96 papers that may use retracted research (e.g. papers studying misconduct; papers seeking to identify problematic research; tools to handle retracted research) or that have limited empirical data (e.g. a single table, a listing of retracted articles in a field, etc.). Further, we have not yet formally reviewed articles that have appeared subsequent to the April 2020 search; ad-hoc literature scanning suggests about 60 new articles that are likely relevant. In our synthesis prior to the workshop, we prioritized areas with direct and obvious relevance to the RISRS problems, such as citation and visibility of retraction status.

In February 2021 we began a formal search update; in addition to systematic search in databases we are screening Scopus citations to the currently included 162 articles where available. Following further analysis of this literature, we are targeting a journal publication to the *Journal of the Association for Information Science*.

Interviews

Stakeholders from across the scholarly communications ecosystem were invited to participate in semi-structured interviews. This process of consultation helped to further refine our scan of the problem terrain and to identify and incorporate different stakeholder perspectives. Interviewees discussed problems associated with retracted research, classes of retracted papers, their role in the publishing industry, and any opinions they may hold regarding the harms associated with retracted research. In addition, participants described the role retracted research plays in their professions and occupations, gatekeepers who might intervene in productive ways, and possible points of intervention to stop the spread of retracted research.

Interviews were subsequently analyzed to identify major themes, divergent points of view, common framings or assumptions, and points of agreement. The resulting analysis was used to design materials, such as the agenda, problem solving cases and discussion scaffolding, to structure participation in the stakeholder workshop. (See Appendix: Stakeholder Consultation Process)

Workshop, Dissemination and Implementation

Organized as a cross-sectoral meeting with participants from across the scholarly communications ecosystem, the three-part workshop facilitated a series of frank, confidential discussions of retraction as a complex problem. In three four-hour online meetings, participants collaborated in a mix of plenary and small working groups to interactively define problems, challenge and reframe expectations, and proposed viable solutions. (see Appendix: Stakeholder Consultation Process) The workshop has resulted in a series of cross-cutting recommendations (see Recommendations) for introducing changes to the way retracted research is framed, characterized, and coordinated amongst a variety of actors in the scholarly publishing ecosystem.

LITERATURE REVIEW & CURRENT AWARENESS

Reasons for Retraction (outline - to be written)

1. Traditional Misconduct
   a. Falsification
   b. Fabrication
   c. Plagiarism
2. Publishing and Peer Review Issues
   a. Redundant publication
   b. Compromised peer review
   c. Faked peer review
   d. Citation manipulation https://retractionwatch.com/2012/07/05/a-first-papers-retracted-for-citation-manipulation/
3. Legal and Approval Issues
   a. Data ownership

b. Legal issues
c. Not having ethical approval
4. Honest but Serious or Pervasive Error
    a. Julia Strand: When Science Needs Self-Correcting: Admitting scientific errors is hard. It's also important.
    b. Pamela Roland: Lab Life: The Anatomy of a Retraction
    c. Research on this topic: Doing the right thing: a qualitative investigation of retractions due to unintentional error (Hosseini et al., 2018).
5. Scientific Issues
    a. Major flaws with the study design or data analysis methods that were not addressed during peer review

Formats and Types for Retraction (outline - to be written)

1. Full retraction
2. A new version, with changes incorporated, receives a different DOI. The original article remains available but clearly marked as retracted.
    a. COPE 2019: "In some instances, journals may wish to work with authors to concurrently retract an article that was found to be fundamentally flawed while simultaneously publishing a linked and corrected version of the work. This strategy of 'retract and republish' is not commonly used, but may provide an opportunity for journals and authors to transparently correct the literature when a simple correction cannot sufficiently address the flaws of the original article (eg, see Retraction and republication – a new tool for correcting the scientific record? European Science Editing (http://b.link/ese)). In this instance, the original article should not be completely removed or 'replaced', but should be retained and linked to."
    b. Called "Retractedandrepublished" in the PubMed XML help https://www.ncbi.nlm.nih.gov/books/NBK3828/#publisherhelp.How_should_I_sub mit_citati
3. Problematic forms of retraction
    a. Partial retraction (not including corrections and errata)
        i. No longer considered good practice.
        ii. The US National Library of Medicine says "Corrections, corrigenda, addenda, and partial retractions (such as for a single graph, statement, table or image) for previously published articles are all uniformly considered by NLM to be errata." https://www.nlm.nih.gov/bsd/policy/errata.html
    b. A new version, with changes incorporated, receives the same DOI as the previous version. The original article does not remain available on the publisher website and cannot be distinguished by DOI from the new one.
    c. Withdrawal
        i. https://www.elsevier.com/about/policies/article-withdrawal
        ii. https://retractionwatch.com/2018/08/01/have-retraction-notices-improved-over-time/

iii. https://retractionwatch.com/2013/02/25/is-an-article-in-press-published-a-word-about-elseviers-withdrawal-policy/

Field Variation

Retraction and its implications have been studied within several different fields or disciplines. Such papers provide information about the prevalence of retraction, the rate of post-retraction citation, the obstacles to preventing the spread of retracted science, retraction policies, and many other pieces of information that may differ from discipline to discipline. Almost half of our 162 included publications study domain-specific aspects of retraction, offering a variety of information on the subject. However, there are also gaps where future research may be useful.

Table 1: Disciplines studied in retraction research

Medicine/Biomedicine/Health and Life Sciences	61
Business/Finance/Economics/Management	3
Engineering	2
Library and Information Science	2
Computer Science	1
Humanities	1
Grand Total	**70**

Table 1 shows the fields that were explored. In the study of retraction, the broad category of Medicine/Biomedicine/Health and Life Sciences is by far the most researched area. This fact is intertwined with the prevalence of PubMed and MEDLINE as data sources in these studies, and some studies used MEDLINE as a data source without any other restrictions by discipline, resulting in a broad definition of biomedical research. While some researchers may have selected PubMed because they sought to study the biomedical field, others may have used it because it is freely available, large in scope, and easy to use. In addition, multi-disciplinary comparisons, discussed below, have also found Medicine/Biomedicine/Health and Life Sciences to be a field responsible for a high proportion of retracted articles.

Other possible reasons for the prevalence of research on retraction in the biomedical field are high-profile cases of retraction in this area, such as Wakefield and Reuben, as well as the obvious consequences that could result from medical treatments influenced by fraudulent or incorrect data. Steen (2011), for example, explored the consequences of the use of retracted studies in medicine, finding that 180 retracted studies involved the treatment of 9189 patients while 70,501 additional patients received treatment in secondary studies that cited those retracted studies. Steen notes that fraud can be harmful both in its impact on treatments and in public trust. In a related study, Steen (2012) found that retracted clinical trials directly involved more patients and influenced more secondary studies than other types of studies, suggesting that clinical research has a high potential for harm when data is fraudulent.

While many researchers studied Medicine/Biomedicine/Health and Life Sciences broadly, others narrowed their research to specific subfields as shown in Table 2. Cancer/Oncology, Clinical

research, and Dentistry are the most researched, with several other fields being researched in one or two articles. Surgical fields are well-represented, with two articles on surgery broadly, one on neurosurgery, and one on plastic surgery.

Table 2: Subfields studied within Medicine/Biomedicine/Health and Life Sciences

Cancer/Oncology	5
Clinical	5
Dentistry	4
Mental Disorders	2
Orthopaedics	2
Radiology	2
Surgery	2
Anesthesiology	1
Drug Therapy	1
Emergency Medicine	1
Genetics	1
Neurosurgery	1
Nursing Science	1
Plastic Surgery	1
Urology	1
Grand Total	**30**

Fewer articles—only 9—focus on specific disciplines outside of medicine and biomedicine. Subjects explored include Business/Finance/Economics/Management, Computer Science, Engineering, Humanities, Library and Information Science (including one focused specifically on medical libraries).

In addition to publications studying retraction within a particular field or fields, some study retraction trends across different fields. It is important to note that greater rates of retraction do not necessarily indicate greater rates of fraud in a particular field. A greater number of retractions can instead indicate greater attention to scientific integrity, as the scholarly community devotes greater attention to removing errors and fraud from the literature (Brainard & You, 2018; Fanelli, 2013). Similarly, variances in policies and attention to scientific integrity may also be a factor in which fields produce the most retractions.

That being said, many studies have found that retraction is most common in medical and biological fields. For example, He (2013) analyzed science subfields in SCIE of Web of Science, finding that the highest number of retractions were in the multi-disciplinary sciences category, though the vast majority of the retractions in that category came from three high impact factor journals (*Nature*, *Science*, and *PNAS [Proceedings of the National Academy of Sciences of the United States of America]*); He notes that factors such as the higher level of scrutiny on publications in these journals could affect retraction rates. The categories with the next most retractions were biosciences, biomedical research, and clinical and experimental medicine.

Similarly, Lu et al. (2013) found that the most retractions occurred in the "hard sciences", particularly in biomedical and multidisciplinary journals. They found lower retraction rates in the social sciences and arts and humanities, believing this to be either because of lower occurrences of error in these fields, or because of lower occurrences of the detection of error.

A study by Halevi (2020) suggests that within these three topics, plagiarism is the most common in Arts and Humanities. The study cites the "essay-like" nature of works in this field as a possible reason for the prevalence of plagiarism, comparing the ease of copying and pasting content into an essay with the ease of manipulating data in the sciences.

Shuai et al. (2017), also studying data from Web of Science, found the highest rates of retraction in medical or biological fields. In an analysis of more specific topics, they found that the most retracted papers discussed gene expressions and regulation of gene expressions.

Other studies note medicine and biology as fields with high retraction rates, but also draw attention to other fields to watch. Interestingly, while Vuong et al. (2020) found a large portion of retractions coming from physical sciences, basic life science, and the health sciences, they also list business and technology as a field with a significant number of retractions. However, we posit that the high number of business and technology retractions might be due to the high number of retractions by the Institute of Electrical and Electronics Engineers, who the study found to be the publisher with the most retractions.

In a study drawing from 42 different databases, Grieneisen and Zhang (2012) found almost 4,500 papers retracted 1928–2011, with the highest rates of retraction in the field of Anesthesiology. They also suggest that retraction rates in Medicine, Chemistry, Life Sciences and Multidisciplinary Sciences are higher than those in Engineering & Technology, Social Sciences, Mathematics, Physics, Agriculture, Earth & Space Sciences, Ecology & Natural Resources and Humanities. In another article, Zhang and Grieneisen (2013) note that rates of retraction due to misconduct in chemistry and non-medical life sciences were comparable to those in medical sciences.

There are challenges to studying field variation in retraction research, such as skewed data due to large numbers of retractions of works by individual authors or publishers in certain fields, differences in the availability of information on different fields, different publication rates, and different levels of attention and scrutiny on publications in different fields. Current research suggests that more retractions occur in the sciences, especially medicine and biology, than in other areas such as social sciences, arts, and humanities. However, existing research on retraction also favors biomedical and life sciences broadly, and more research into non-biomedical fields, specific biomedical subfields, and the reasons for field variation may prove useful to understanding the phenomenon of retraction and how it is handled in different disciplines.

Explaining field variation in retraction requires significant interpretation of existing studies, which generally either analyze the items that have been retracted or the authors with the most retractions. The extent to which work is empirically grounded in evidence directly reported is one difference between fields. For instance, the presentation of image data in the sciences (in article

figures) provides a certain level of transparency/visibility, and also a point of research reporting where errors or alterations can be introduced. Issues pertaining to image data reporting are highly represented in retractions (Bik et al., 2016). Applied fields may gain scrutiny from a wider audience than more abstract ones. Field norms also vary; for instance, in mathematics, incorrect proofs of challenging problems such as the Four Color Theorem and Fermat's Last Theorem continue to be publicly discussed, despite their known incorrectness. Differences in the genre of publication (articles versus conference papers versus book chapters and books) may also make a difference. Whereas retraction gained publicity in the medical sciences in the early 1980's (Kochan & Budd, 1992), many fields have started to retract items only in the last decade or two.

Continued Citation of Retracted Papers: What Went Wrong?

Retracted papers may receive a considerable number of citations. A comprehensive survey of retracted articles in Web of Science found that retracted articles on average receive 22.29 citations (Chen et al., 2013). Narrowing down to the biomedical field, one study found retracted articles were cited 35 times on average (Dinh et al., 2019). A similar number of average citation counts, 35.1, is found in oncology (Pantziarka & Meheus, 2019), a subfield of biomedicine.

Papers continue to be cited after their retraction. A concerning observation is that retraction had *no* impact on the total number of citations: Bolboacă et al. (2019) compared Weighted Citation Indices (the number of citations divided by the citation time window) *before* and *after* retraction of retracted radiology papers taken from PubMed and found no significant difference. Neale et al. (2010) compared citations of retracted papers with adjacent un-retracted ones and found no evidence that retracted papers received fewer citations. Moreover, post-retraction citations should document the retracted paper's retraction status. A study of citations of Wakefield's autism/MMR vaccine paper (partially retracted in 2004 and fully retracted in 2010) found a steady increase of the papers documenting the retraction status from 2005 (38.2%) to 2018 (88.5%) (Suelzer et al., 2019).

Bibliometric researchers have long suggested that not all citations should count equally; for instance Eugene Garfield mentioned "Disclaiming work or ideas of others (negative claims)" as one purpose for citing (Garfield, 1965). The term 'citation sentiment' has been taken up, particularly in the natural language processing community, following sentiment analysis, dating at least to Athar (2011). In work on post-retraction citation, the definition from Suelzer et al. (2019), is typical: negative citation "disputes, corrects or questions, or negatively evaluates cited work". Using that definition, the majority of the citations (72.7%) to the Wakefield paper are negative (Suelzer et al., 2019). Unfortunately, this does not apply to retracted papers in general.

A series of studies have shown the disturbing fact that negative citations and citations documenting the retraction status only account for a small fraction of post-retraction citations (Table 3). It is both important and interesting to investigate why post-retraction citations are predominantly positive (i.e., citing retracted work as if it were still valid). It is natural to think that low visibility of retraction status is the cause. However, studies that establish such causal relationships are still needed. By studying one retracted paper that has been repeatedly cited,

Schneider et al. (2020) found that errors in database metadata and library link resolvers may have prevented users from seeing the retraction notice when they searched for this retracted paper. Balhara & Mishra (2014) assessed compliance of retracted publications with Committee on Publication Ethics (COPE) guidelines, comparing data from before the introduction of the COPE guidelines in 2009, and after. They found that the difference between pre-2010 and post-2010 retraction notices was small. They also found that the lack of a freely available retraction notice led to a "statistically significant" increase in post-retraction citations.

Table 3: Fraction of negative post-retraction citations and citations documenting retraction status reported by research articles

Reference	Fraction of negative citations	Fraction of citations that documents the retraction	Total number of post-retraction citations studied	Sample taken from	Citations from
(Kochan & Budd, 1992)	8.4%	5.7%	298	John Darsee's publications	Science Citation Index
(Budd et al., 1999)	--	6.4% (Abridged Index Medicus (AIM) citations) and 7.7% (non-AIM citation)	AIM citations: 299; non-AIM citations: 1594	MEDLINE	Science Citation Index
(Neale et al., 2010)	.3%	2.8%[1]	603	102 papers named in official findings of scientific misconduct during the period of 1993 and 2001	Web of Science
(Budd et al., 2011)	--	6%	391	PubMed	Scopus
(Bornemann-Cimenti et al., 2016)	--	25.8%	267	19 papers from the Scott Reuben case	Web of Science Core Collection
(Budd et al., 2016)	--	4.15%	4,917	MEDLINE OVID	Scopus
(Bar-Ilan & Halevi, 2017)	5%	--	238	ScienceDirect	Scopus
(Bolboacă et al., 2019)	2.33%	1.07%	559	43 radiology diagnosis papers from PubMed	Scopus

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[1] We chose to compare with what Neale et al. call "direct contrast".

(Hamilton, 2019)	--	8%[2]	358	46 radiation oncology papers	Web of Science, Scopus, and Google Scholar
(Suelzer et al., 2019)	72.7%	56%	881	Wakefield paper	Web of Science Core Collection
(J. Schneider et al., 2020) updating (Fulton et al., 2015)	3.5%	4.5%	112	A single retracted clinical trial from the Matsuyama case	Web of Science, Scopus, and Google Scholar
(Piller, 2021)	--	47.5%	200	Two retracted COVID-19 papers related to Surgisphere data	--
(Hsiao & Schneider, n.d.)	--	4.6%	13,256	PubMed Central Open Access subset (XML only)	iCite

Studies of post-retraction citations also challenge our assumptions about researchers' information behavior, including their information management and information practices. For example, the role of mass media should not be underestimated. Reduction in post-retraction citation has been found in a few high-profile retraction cases but not those less well-reported (Mott et al., 2019). Another study using the Altmetric Attention Score (from altmetric.com), a measure based on news and social media attention and online search data, made the unique discovery that retracted papers with high Altmetric score (i.e., more online attention) were more likely to result from misconduct and also received fewer citations (Shema et al., 2019). Moreover, researchers outside a field tend to be more prone to citing retracted papers than researchers inside the field (Bornemann-Cimenti et al., 2016). Thus, there should be further studies to understand the difference between in-field and out-of-field researchers regarding how they receive information about retractions. Problematic citation behavior is another concern. If authors copy references from others without checking the original paper or retrieve papers from unofficial channels (e.g., pirate copy sites, self-archives, academic social networks) (Dubin, 2004; Simkin & Roychowdhury, 2005; Wetterer, 2006), merely improving the visibility of retraction status in publishers' websites or databases will still be inadequate. Education of authors is important. Moreover, a reference-checking step in the publication process should be considered to be another, potentially final, defense against the unknowingly citation of retracted work.

Papers citing retracted articles are not subject to any additional scrutiny, and such citations raise the concern that errors may propagate for generations into the scientific literature and damage its integrity (J. Schneider et al., 2020; van der Vet & Nijveen, 2016). In fact, retracted articles in nursing science journals were found to be cited by systematic reviews as evidence, and some of the systematic reviews were published after the retraction (Gray et al., 2018). To prevent such diffusion, 2019 COPE guidelines mention that systematic reviews must consider correction or

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[2] Inferred from the data reported (subtraction).

retraction following retraction of a publication they synthesize (COPE Council, 2019). Network analysis has been applied to visualize such propagation (Chen et al., 2013; van der Vet & Nijveen, 2016). Thus, besides preventing scientists from using and citing retracted articles unknowingly, we must also ask how to deal with positive citations already existing in the archive. To develop a formal approach, (Fu & Schneider, 2020) introduced a new framework, the keystone framework. It combines argumentation theory, argument-based modeling of scientific paper, and citation content analysis. Using the framework, users can differentiate citations that *do not* impact the validity of the citing paper from citations that *do* impact the validity of the citing paper. In the former case, a mark can be placed next to the citation so that readers will be informed of the potential validity issues with the citation contexts. However, in the latter case, the validity of the entire citing paper is called into question. Additional measures (e.g., alerting authors to double-check their results) need to be taken to prevent science being built on "shaky" or "absent shoulders" (Azoulay et al., 2015).

However, researchers do find legitimate reasons to cite retracted papers. The most common one is to critique them, so called "negative citations". Retracted papers may also be cited as a part of history in a review (Osman et al., 2017 ref 39), as the reason for exclusion in systematic reviews and meta-analysis (e.g., Palacio et al., 2014 ref 45), to justify more research effort (e.g., Sehnal et al., 2015 ref 1-4)), or to reduce the strength of evidence supporting opposing views (e.g., Thomas Manapurathe et al., 2017 refs 45 and 46). Therefore, if researchers do want to properly cite a retracted paper, what should they do? The current recommendation is that authors should (1) note the retraction (e.g., in the article text or citation) and (2) cite both the paper and the retraction notice (Oransky, 2018a). However, meeting the second suggestion is not easy: not all citation styles include guidance for citing retractions. Even when a citation style does include clear guidance, as the American Medical Association (AMA) Manual of Style (Christiansen et al., 2020), National Library of Medicine/Vancouver Style (Patrias & Wendling, 2018), and American Psychological Association (APA) Style (American Psychological Association, 2019) do, citation management software often cannot translate relevant bibliographic data (e.g., retraction notice publication date, volume number, page number) into properly formatted reference items (Suelzer et al., 2019). Improvements in guidelines and citation management software are needed to help authors cite retractions properly and easily.

Visibility of Retraction Status

The visibility of retraction status should be considered from the publisher's as well as the reader's perspective. From the publisher's perspective, visibility of retraction status can be significantly compromised when indicators of retraction status are inconsistently applied. For example, document types designated for retracted publications, as well as links between retracted publications and their notices, are not present in all cases (Proescholdt & Schneider, 2020; Schmidt, 2018). Additionally, database search results do not always sufficiently identify an item having been retracted. In one search for a particular author's retracted papers around five months after their retraction, 94% were identified as retracted in Medline, but only 6% were identified as retracted in EMBASE (Wright & McDaid, 2011). In the online journals where these articles were published, their status as retracted was only unmistakable in five out of nine cases (Wright & McDaid, 2011). Another study of the Korean medical database KoreaMed showed that many

retracted articles lacked watermarks on the journal homepages; however, the presence or absence of a watermark had no apparent effect on the number of times an article was cited post-retraction (Kim et al., 2019). Moreover, a discussion paper for this workshop has drawn attention to the inconsistent display of citations even within the same publisher (Suelzer et al., 2020). To solve this problem, publishers and databases should reach a consensus regarding how to apply indicators of retraction status and consistently apply such standards throughout their websites and databases.

However, visibility created by publishers and databases cannot guarantee visibility for users. Many retraction notices are still not freely available, despite COPE guideline's recommendations (Wiedermann, 2018; Wright & McDaid, 2011). Copies of retracted papers in personal libraries and on non-publisher websites may not reflect the retraction status, for instance if the article was downloaded or incorporated into the library/repository before the retraction date (Davis, 2012). One study found only a quarter (26%) of the retracted articles identified through those resources contained some retraction statement (Davis, 2012). Fortunately, technology has enabled tangible solutions for closing this loophole. For example, Zotero's retraction notification can deliver messages to users about retraction status. CrossMark, a service from CrossRef, allows users to retrieve the current status of the paper with a single click. Still, an expansion of retraction notification to all reference management software is necessary, and information literacy such as checking the status of a paper before citing it should be a part of the basic curriculum for researchers. Furthermore, the utility of such tools depends on the accuracy and completeness of the references/citations themselves.

Inconsistent Retraction Metadata

Consistent and useful metadata related to retraction is necessary to ensure that a researcher can understand the status of a given publication, locate items that have been retracted in a database, and not overlook that fact that a publication they are citing is retracted. It also enables publishers, databases, and other stakeholders to implement machine-actionable metadata exchange, and to clearly communicate about retraction statuses. However, a challenge of taxonomy must be addressed before metadata can be consistently applied across stakeholders, as metadata terms related to retraction status (e.g., retraction, erratum, correction, corrected and republished article, retracted and replaced article, withdrawal, etc.) can signify different concepts to different parties. What one publisher refers to as a 'withdrawal' might be called a 'retraction' by another. 'Withdrawal' is a term often applied to pre-prints, but is sometimes applied in other situations as well. Also, while Crossref's Crossmark can help make retraction status more visible, and provides a list of twelve terms to describe various types of updates (*Crossmark*, n.d.), this approach allows publishers to apply terms as they choose, without set definitions for the twelve terms or the relationships between them.

Additional metadata fields, such as reasons for retraction, have also been used in the Retraction Watch database. This metadata may be useful for some purposes, though some workshop participants expressed concerns that a taxonomy that detailed may be too complicated to be broadly adopted across publishers and databases, and that a simpler taxonomy of five or so terms for retraction category/classification would be a more practical starting point. A working

group is being formed by workshop participants to address the creation of a taxonomy that can help establish a more consistent language to refer to retraction status.

Other metadata issues include updating the paper without updating the DOI, which can make it difficult for researchers to find the original paper and understand the differences between the two. Additionally, within databases, publisher websites, and other sources, the metadata of publications that have been retracted is not always updated to reflect the retracted status. For example, PubMed, Web of Science, and Scopus were all found to contain retracted items not labeled with retraction-related document types, with PubMed containing 58, Web of Science containing 56, and Scopus containing 8654 items that were likely retracted publications or retraction notices, but were not labeled with retraction-related document types (Proescholdt & Schneider, 2020). Schmidt (2018) previously identified issues with missing retraction-related metadata in PubMed and Web of Science for retracted publications and retraction notices. Inaccuracies in metadata hinder communication and research involving retracted publications.

Quality of Retraction Notices

How should a retraction notice be written? As of 2019, the guidelines from the Committee on Publication Ethics (COPE) recommend that notices of retraction should: "(1) indicate who is retracting the article; (2) state the reason(s) for retraction; and (3) be objective, factual and avoid inflammatory language" (COPE Council, 2019). Rules 1 and 2 are also stated in the 2009 version of COPE guideline for retracting articles (COPE Council, 2009) as well as in the International Committee of Medical Journal Editors (ICMJE) guidelines (International Committee of Medical Journal Editors, 2019). In 2005, Retraction Watch published their own standard, more detailed than COPE (Oransky, 2015). Table 4 summarizes empirical studies on retraction notice quality. Current data are insufficient for us to draw a conclusion about the current level of compliance with COPE guidelines. Only one study covered both reasons for retraction (COPE guideline rule 1) and the authority retracting the article (COPE guideline rule 2) (Vuong, 2020), and the rest only assessed one or the other. Moreover, most studies sampled retraction notices over a long period, and the low fraction of retraction notices that do meet the standards might be the result of including historical notices. Only one article reported results based on retraction notices from two single-year periods (2008 vs. 2016) from a single database (PubMed) (Decullier & Maisonneuve, 2018). In summary, a more systematic assessment of retraction notice quality is needed. Such an assessment should examine retraction notice quality in a more granular time scale, take samples from multiple databases, and better still, evaluate retraction notice quality beyond the minimum requirements of the COPE guidelines.

Table 4: Retraction notice quality studies and their results

Reference	Database studied	Period studied	Fraction of retraction notices that **stated** who is retracting the article	Fraction of retraction notices that **stated** the reason(s) for retraction
(Decullier & Maisonneuve,	PubMed	2008	--	91%

2018)				
(Decullier & Maisonneuve, 2018)	PubMed	2016	--	99.2% However, a shortcoming is that 16/123 withdrawn items were excluded (Oransky, 2018b)
(Xu & Hu, 2018)	Web of Science	1966-2017	71.08%*	--
(Tripathi et al., 2018)	Scopus	2000-2017	--	3.6%
(Tripathi et al., 2019)	Web of Science	2008-2017	--	0.8%
(Vuong, 2020)	Retraction Watch	1975-2019	47%*	90%

* inferred from the data reported (subtraction)

The language of retraction notices is another aspect for us to consider. Ambiguity and lack of sincerity are two problems exposed so far. Retraction Watch keeps a category called "unhelpful retraction notices," including retraction notices giving reasons for retraction but in opaque language (Marcus, 2018; Stern, 2018). A few rhetorical analysis studies also found that authors of retraction notices often use rhetorical strategies (e.g., the use of passive voice and third-person pronouns) to evade their responsibilities (Hesselmann & Reinhart, 2019; Hu & Xu, 2020). We suggest a discussion among authors, editors, and publishers to determine what obstacles there are to including detailed retraction information in retraction notices.

Literature Review Conclusions

Empirical research has exposed a wide range of problems related to the dissemination of retracted papers. Papers continue to be cited after their retraction, and (at least in biomedicine) the predominant majority (>90%) of post-retraction citations still describe retracted papers as valid work (Hsiao & Schneider, n.d.). The existence of those citations threatens the integrity of the scientific literature and compromises the utility of retraction as a self-correction mechanism for science. Moreover, even when authors find legitimate reasons to cite retracted papers, they face obstacles including the lack of citation guidelines and limited software support. The low visibility of retraction status is often hypothesized to be the cause of unknowing citations. Studies have found low consistency in applying indicators of retraction status across different publisher sites and within the same publisher site. On the other hand, scientists' information behavior should be considered, as problematic citation behavior may contribute to the prevalence of unknowing post-retraction citation. Finally, retraction notices should carry crucial information about who is retracting a paper, and why, but in some cases this information is missing (Balhara & Mishra,

2014; Snodgrass & Pfeifer, 1992; Tripathi et al., 2018); even when a reason for retraction is given, it is not always clear whether the cause was misconduct or honest error (Moylan & Kowalczuk, 2016). Guidelines exist for what information a retraction notice should contain (COPE Council, 2019; International Committee of Medical Journal Editors, n.d.). Although many authors in our data set promote the adherence to COPE guidelines as remedies for many problems, these guidelines have not been consistently followed in practice to date. In addition, retraction notices are often found to be ambiguous and to use rhetorical strategies to evade responsibility (Hesselmann & Reinhart, 2019; Souder, 2010). More discussions are needed to reach a consensus among authors, editors, and publishers as to industry-wide standards for retraction notice contents.

DEFINING PROBLEMS AND OPPORTUNITIES

The role of the 'problem definition' in agenda-setting processes has long been studied in the policy and social sciences. As an aspect of the policy process, problem identification is broadly assumed to be the initial step of policy development. Problem definitions set the tone for ideas to move through agenda setting, policy development, adoption, implementation and policy evaluation (Baumgartner & Jones, 2015; Kingdon & Stano, 1984; Weiss, 1989). In the social sciences, a complimentary line of inquiry examines the development and role of research agendas in policy and regulatory processes (Blumer, 1971; J. W. Schneider, 1985). In organizational contexts, problem definitions contribute to the emergence of issue cycles, shaping the emergence and resolution of public issues (Bigelow et al., 1993). A recent subset of this literature examines the intersection of policy and research agendas in sociotechnical systems (Sovacool et al., 2020).

Problem definitions or frameworks refer to perceptions and background assumptions that, when combined with a body of facts, help to frame social and technical issues. Composed of linked ideas about the scope and importance of an issue, problem definitions help to organize collective action, and guide how an issue may be productively resolved. As a feature of the agenda-setting process, problem definitions define a horizon of expectation for proposed solutions, as well as opportunities for intervention. Although problem definitions shape the perceived scope of an issue, they are also subject to change over time and redefinition as public issues are taken up as aspects of policy or as the focus of collective action.

Here, we take up the issue of problem definition as a feature of agenda setting, particularly as it relates to the perception of retraction as a social and technical issue in the scholarly communications ecosystem. The production, communication, circulation, use, and preservation of scholarly materials is defined and organized by the interests of multiple stakeholders. While it is clear that retraction is a complex problem involving multiple aspects of scientific research and scholarly communications, we here focus on the continued citation and use of retracted research. Our research questions focus on the varied stakeholder perceptions of the types of retracted papers, the harms associated with retracted research, the intervention points to intervene to stop the spread of retracted research, the gatekeepers who can disseminate retraction status, and any impediments to the public dissemination of retraction notices. In this

way we clarify differences in perception, and identify areas of agreement over the problem definition or perceived solutions.

In this section, we examine problem definitions and linked intervention opportunities from two perspectives. First, we identify perceptions of problems and opportunities in the empirical literature on retraction. Second, we examine stakeholders' perceptions of problems and opportunities based on the stakeholder consultation process. Finally, we conclude this section with comparisons of the most salient problem-definition assumptions identified in this analysis.

PROBLEMS AND OPPORTUNITIES DESCRIBED BY THE EMPIRICAL LITERATURE ON RETRACTION

Following the screening stage of the scoping review (covering searches up to April 2020), we used 143 of the 162 central papers focused on the empirical research on retraction (See Appendix: Problems and Opportunities Dataset). From this set of papers, we extracted textual data in the form of coded quotations. As part of an initial data extraction process, we had already extracted blocks of text related to problems & opportunities from the discussion and conclusion sections of these 143 papers.
We took these blocks (one per paper) and did a coarse thematic analysis, identifying as many themes per block/paper as relevant. From this set of themes we produced a concept map of the major problems and opportunities. In each source paper's discussion section, items could be discussed as either problems or opportunities depending on how the authors framed the discussion. This procedure resulted in 41 distinct codes associated with problems and 38 codes associated with opportunities for addressing the problem of retracted research in the scholarly communications ecosystem.

Here we discuss the results of this analysis. We focus first on the problems related to retracted research and its continued citation identified in the literature. Second we describe perceived opportunities for addressing these problems, according to the literature. These problem areas are then analyzed to examine agreements and disagreements over the definition and scope of the perceived problem. can be analyzed by overlap to map the major problem themes as well as identification of productive points of intervention to address these problems.

Problem Themes Described by the Empirical Literature on Retraction

We used 41 different codes to identify problems associated with retracted research. These individual problems further cluster into 6 problem areas. Table 5 illustrates the main problem themes we identified through coding.

Table 5. Problems

Problems Themes	Number of Problems
Problems with Reasons for Retraction	46
Problems associated with Stakeholder Communities	42

Problems Associated with Continued Citation	28
Problems with the Visibility of Retraction	13
Impacts of the Retraction Process	5
Differences in Institutional Contexts	5

When sorted by problem theme, the largest number of quotations highlight problems associated with the categorization of retractions, and a cluster of concerns focus on the difficulties involved in determining why a paper has been retracted, how to determine why a paper is retracted distinguishing reasons for retraction, and whether the reasons for retraction are properly disseminated in a retraction notice. In general this theme concerns the data to properly assess the cause of retractions, whether it exists, or whether reasons for retraction are sufficiently reported. Within this theme two linked areas stand out as areas of primary concern. The first is the issue of misconduct, and whether misconduct is driving the rate of retraction. The second focuses on the nomenclature and the policies associated with describing reasons for retraction.

The second largest problem theme concerns problems associated with specific stakeholder groups. We identified three stakeholder groups mentioned in the literature. These are publishers and editors, libraries, the media and researchers. The literature highlights the nature of retraction as a systemic problem that reaches beyond specific domains to touch the work of other stakeholder groups. Here we discuss the two largest themes, moving from publishers and then on to researchers.

Of these themes, publishers receive the most attention with 21 proposals suggesting some type of publishing reforms. Here, the literature highlights the lack of standardized publication policies regarding retraction. Atlas (2004) notes in this regard, "Few journals have publicly stated policies, most seem to believe it will not happen to them, and, if it does, they will handle it based only on the particulars of the specific incident and not on a well-thought out and well-publicized policy." Additionally, the issue of adoption and adherence to COPE/ICMJE guidelines regarding retraction is prominently framed both as a problem, related to the broader issue of inconsistent policies, and as a solution to the issue of retracted research and its continued citation. This discussion centers on the efficacy of the COPE/ICMJE standards, the consistency of compliance with COPE recommendations or guidelines, and the standardization of publishing policies more generally.

In our data set the second largest stakeholder group is researchers. The largest concern associated with researchers is authorship and co-authorship of retracted papers. Two notable themes here are worth mentioning, namely the impact of misconduct-related retraction on co-authors, and second, the rhetorical evasion of authorial accountability in the authoring of retraction notices. Mongeon & Larivière highlight the issue of 'costly collaborations' noting "scientific fraud in the biomedical field is not only harmful to science as a whole and, at the individual level, to the fraudulent scientist, but also to the innocent scientists whose only fault might have been choosing to work with the wrong colleague," (Mongeon & Larivière, 2016).

Markowitz & Hancock highlight the possibility of evasion, noting, "Scientists reporting fraudulent data wrote their reports with a significantly more obfuscated writing style than unretracted papers and papers retracted for reasons other than fraud (e.g., ethics violations, authorship issues)" (Markowitz & Hancock, 2016, p. 8). Here, Mongeon & Larivière highlight a potential cumulative disadvantage to collaborating with those who conduct scientific fraud. By contrast, Markowitz & Hancock draw out the potential outsized impact that retraction notices may have on the continued citation of retracted research.

Issues related to post-retraction citation follow closely behind these two large problem themes, figuring as a central concern in the literature. Problems in this category are primarily discussed in terms of the persistence of post-retraction citation; the time it takes to correct the literature; and differentiating valid from invalid science at the level of citation. Three observations regarding continued citation stand out. First, "many citations come from citing secondary sources, which would prevent citers from seeing the retraction notice posted on the original article." (Mena et al., 2019). Secondary sources here refer to researchers adopting citations from papers removed from the original paper, for example, from related papers, or bibliography. This relates to the second observation, that many citations are copied from the reference lists of other articles (Hamilton, 2019). Both bring into focus the limitations of efforts to make retractions visible, through watermarking or linked retraction notices. In the age of digital dissemination this is potentially a more vexing problem where "articles even after retraction are continuously being discussed in the social platforms with highest shares on Twitter, Mendeley, blogs, peer-review sites etc." (Jan & Zainab, 2018). Together, these observations raise the question of how users interact with the citation ecosystem.

Tightly coupled to this issue of citation behavior, visibility is discussed in the literature as both a problem and a solution to retraction. Many papers report the limits of strategies to make retracted research visible. This in turn limits an author's ability to cite retracted research appropriately. For our data set, where authors discussed retraction as a problem, we see a major focus on whether readers are aware that research has been retracted prior to citation, or whether a watermark has been used to denote retraction status.

The impact of the retraction process is also a topic of concern, with a number of papers framing the issue of impact in terms of career stigma, as well as financial impacts. Finally, the problems associated with the theme of 'institutional diversity' largely concern the issue of under resourced organizations and variation in standards. An overriding concern in this problem area is the question of whether institutions, particularly in the developing world, have sufficiently developed capacity for ethics and integrity training.

Opportunity Themes Described by the Empirical Literature on Retraction

From the above set of 143 papers, 38 separate codes were associated with opportunities to address or resolve the issue of retractions or the continued citation of retracted research. These discrete proposals can be similarly clustered into eleven discrete 'opportunity areas' to address the problem of retraction, and its continued citation, within the publishing ecosystem (see Table 6).

Table 6. Opportunity Themes

Opportunity Themes	Number of Opportunities
Implementing Stakeholder Reforms	161
Adopting Review Strategies	47
Refining Retraction Classification	27
Innovating Visibility Strategies	24
Addressing Institutional Constraints	19
Further Research	5

The largest of these opportunity themes broadly concerned implementing stakeholder reforms to target how researchers, publishers and editors, libraries, and professional associations manage retracted research in the scholarly communications ecosystem. In the empirical literature on retracted research, the greatest number of reform propositions in the discussion sections were coded as targeting reforming publishing practice. By contrast a smaller number of the codes in our data set focused on reforming how scholars produce scholarship, or mobilizing specific stakeholders to influence change (see Table 7).

Table 7. Areas of Stakeholder Reform

Area of Stakeholder Reform	Number of Proposals
Reforming Publishing Practice	70
Reforming Scholarly Practice	33
Mobilizing Stakeholder Influence	33
Educating Stakeholders	25

The reform of publishing practice refers to proposals that target industry-wide reforms to the publishing industry. These consist of reforms to the publishing industry's adherence to the COPE/ICMJE standards; the implementation of industry-wide checklists; standardized editorial policies; cross-industry quality control guidelines; and generalized industry policies on reporting to repositories and other venues; standards regarding retraction notice quality, including detailed consistent reasons for retraction, or the development of a standardized retraction form. In some instances, these suggestions are couched in generalized appeals to "universal publishing standards to minimize the continuing citation of retracted articles as valid work," (Wasiak et al., 2018), including adoption of standards to promote "transparency and openness in scientific communication," (Wasiak et al., 2018) or "universally accepted standards for unambiguous retraction" (Wiedermann, 2018).

Proposals to reform scholarly practice consist of ideas to change how science is done to incorporate higher standards of transparency, clear norms regarding misconduct, and stronger standards of replication and reproducability. In regards to transparency, some advise that the proprietary attitude of academics to data should be "superseded by an obligation to demonstrate ethical research practices by lodging data in a way that facilitates inspection, reanalysis, and replication" (Tourish & Craig, 2020). Reform strategies also propose new approaches to how science is conducted. Trikalinos suggests that while "Trust is fundamental for scientific progress," the scientific community should encourage "the careful, rigorous replication of research findings by other teams" (Trikalinos et al., 2008). The reform of research culture also includes naturalizing the correction of error in the scholarly record, where "research mistakes, like all human errors, must be seen not as sources of embarrassment or failure, but rather as opportunities for learning and improvement (Nath et al., 2006).

Some authors suggest broad measures that cut across stakeholder groups. Wasiak et al., for example, highlight a coordinating nexus of stakeholder reform strategies that include that involve "support for a stand-alone retraction studies database" coupled with "authors signing compulsory declaration forms that detail antiplagiarism guidelines," and for publishers to adopt "guidelines that support standards in transparency and openness in scientific communication" (Wasiak et al., 2018). Others emphasize a coordinated vigilance on the part of "reviewers, editors, and readers" to report suspect citations and coordinated "investigations by institutions, government agencies, and journalists in identifying and documenting research misconduct" (Fang et al., 2012).

The next largest theme focuses on the adoption of various review strategies to mitigate the continued citation of retracted research. These include automated review procedures to detect plagiarism, checking publications at the time of submission for plagiarized material. A similar proposal suggests publishers adopt a similar procedure during submission where an articles reference list is scanned to detect retracted citations as well as plagiarized material. Some of these proposals include incorporating Crossmark (*Crossmark*, n.d.), while others note editors and researchers should frequently check Retraction Watch (*Retraction Watch*, n.d.) to monitor for retracted research and to review citations employed in their papers.

A related body of proposals focus on refining the retraction taxonomies used in retraction notices, and in innovating new strategies to enhance retraction visibility. The proposals in each set are similar to those identified in the problem themes, where lack of retraction notice specificity is highlighted as a problem to be solved along with the visibility of retracted material. One proposed solution is the adoption of standardized retraction categories that can be used to denote the type of amendment made to the article, and the reason for retraction. For example, Moylan & Kowalczuk note that in order to improve transparency, "publishers could enforce the use of an internal checklist capturing the main information required in a retraction notice along with template wording as previously proposed," (Moylan & Kowalczuk, 2016). This issue of a common retraction taxonomy is contextually linked to the issue of visibility where many argue that "it is essential to make the retracted articles transparent, visible and clear to readers in order to avoid post retraction citation," (Bolboacă et al., 2019). To achieve this some argue for

"a prominent placement of the word 'retraction' on the first page" of an article, noting that once an article is downloaded, retraction notices are often "left behind" (Neale et al., 2007).

A small number of proposals focus on issues of institutional constraints, while others call for additional research. Institutional constraints refer to reforms that purge research institutions of research misconduct, and create more money and incentives for research integrity, and greater punishments.

Problem Definition Described by the Empirical Literature on Retraction

Two problems themes stand out as shown in Table 8: misconduct as a reason for retraction and reasons for retraction (in general). Misconduct as a reason for retraction speaks to two concerns: the question of what is driving retraction and the quality of information reported in retraction notices.

Table 8. Most discussed individual problems

Problem Themes	Problem	Number of Proposals
Problems with Reasons for Retraction	Misconduct as a Reason for Retraction	33
Problems with Reasons for Retraction	Reasons for Retraction	26

Likewise, two opportunities themes stand out as shown in Table 9: guidelines and policies within the publishing industry and clear reasons for retraction. Authors suggest clarifying how an article has been amended and why; this would promote data quality and ensure the visibility of the retraction itself.

Table 9. Most discussed individual opportunities

Opportunity Themes	Opportunity Pathway	Number of Proposals
Publishing Industry	Guidelines and Policies within the Publishing Industry	24
Publishing Industry	Clear Reasons for Retraction	23

Comparing the problem and opportunity themes, we notice an overlap in the codes: the most frequent codes concern reasons for retraction and guidelines and policies for retraction notices.

THEMES FROM STAKEHOLDER DISCUSSIONS

In the stakeholder consultation process, stakeholders from across the scholarly communications ecosystem were invited to participate in semi-structured interviews (SEE Appendix: Stakeholder Consultation Process). Here we review problems and opportunities from these stakeholder conversations along with broader themes relevant to issues of implementation.

Problem Frameworks based on Stakeholder Discussions

In these consultation interviews, we identified three problem frameworks. These are background assumptions that meaningfully shape the scale and scope of how the issue of retracted research is defined as a problem and subsequently evaluated and framed by stakeholders. These are the 'risk framework, the 'self-correction' framework, the 'wrong-doing' framework, and the 'risk' framework. The 'risk' framework concerns how stakeholders frame stigma and evaluate the risks associated with retracted research, whereas the 'self-correction' and 'wrong-doing' framework refers to the background assumptions stakeholders adopt when discussing the relationship between retraction and science as a social institution or cultural practice.

The 'risk' framework concerns stakeholders' orientation to the risks associated with retracted research, often framed in terms of stigma. We see this, for example, in the impact that retraction processes have on multiple stakeholder communities. Researchers, for example, face career impacts, by way of reputational damage. Editors likewise report issues of stigma, and a reluctance to engage in retraction processes due to career and reputational impacts as well as fear of litigation. Here, the harms associated with retraction include reputational damage, lack of support from their publishers, and fear of the hostility associated with uncooperative and potentially litigious researchers. Many stakeholders additionally report emotional tolls that speak to broader personal impacts, such as psychological issues and relationship stress.

The 'self-correction' framework concerns the question of what retraction means for the conduct and communication of science. Here, one assumes science is a 'self-correcting system' and the role of retraction, as coupled with other interventions, such as corrections, is to clean up errors in the literature. Many stakeholders viewed the prevalence of retracted science as an indicator of the health of scientific publishing—that the system was in fact working to clean up the literature. To some degree this assumption is reflected in the literature (Fanelli, 2013), but we also found it to be a prevalent assumption active throughout the stakeholder consultation process. There is some question of whether the notion of science as a self-correcting system is inclusive of non-scientific scholarship. Is it useful to view all research as self-correcting?

This assumption is usefully contrasted with a second background assumption—the 'wrong-doing' framework—active where stakeholders assume that the prevalence of retractions is best understood as a failure of scientific practice, and hence a problem with either the methods utilized, or the conduct of individual scientists or scholars. The continued citation and use of retracted research is best addressed, on this body of assumptions, through repair of the methods used to conduct, review, and evaluate science.

Both the 'self-correcting' and the 'wrong-dong' framework hold direct implications for how we understand the continued citation of retracted research and how we evaluate solutions to the continued citation of retracted research.

For those who view retraction primarily as a tool to clean up the scientific or scholarly record, or as part of science as a self-correcting process, the issue of retracted research, its continued citation and use, is best addressed through an optimized means to communicate retraction as part of established scholarly communications processes.

By contrast, for those who view retraction primarily as an outcome of either flawed research or scientific misconduct, the primary issue is not how retracted science is communicated, but rather how to quarantine or remove flawed publications. Under this assumption, solving the continued citation of retracted research is best achieved through broader reform measures that emphasize the period before flawed research enters the scholarly record. Reform recommendations in this vein include methodological and ethical reforms, but also how researchers, as authors, understand and navigate scholarly publishing. Other recommendations focus on the reform of peer review, issues of reproducibility, or more generally the importance of addressing the integrity of research before it is communicated, and hence before it might be cited.

Finally, the continued citation of retracted science is often treated as a type of misinformation, and hence framed as a much broader issue of notable significance. Treating retraction as misinformation holds implications for the public nature of science, and questions regarding the public trust in science. In a more limited sense, the circulation of scientific misinformation, 'fake science' and disproven science, is particularly concerning for the use of scientific evidence in a variety of regulatory processes.

Many stakeholders were concerned specifically with the loss of trust in science and scholarship. This includes concern with the problem of how to address the destabilizing effects of retraction on the use of scientific evidence in regulatory and governance processes. Linked to this concern, some stakeholders wanted the public to understand 'science as a self-correcting process'. Likewise, in consultation and during the workshop, a number of stakeholders were keen to address the circulation and public reception of scholarly preprints.

Contentious Themes based on Stakeholder Discussions

Stakeholders also expressed in conversation a range of assumptions that may in conversation be glossed as 'semantic differences.' In the weakest sense, these differences are active as unspoken premises for framing problems and opportunities. In a stronger sense, they may also function as implicit agreements or disagreements over the meaning and scope of what it means to amend the scholarly record. These 'contentious themes' consist of differences of opinion over the purpose of retraction; how to incorporate changes to the scholarly record; the impacts or harms associated with retraction; and the character of reform.

The Purpose of Retraction According to Stakeholders

In the previous section we reviewed two broad background assumptions regarding the purpose of retraction, the 'self-correcting' framework and the 'mis-conduct framework.' Both broadly frame the purpose of retraction. However, it is clear that there are additional themes associated with the purpose of retraction, particularly regarding the definition of retraction, and its broader role within the scholarly publishing ecosystem.

From our conversations with stakeholders it became clear that the definition of retraction is not commonly held across all stakeholder groups. For example, some suggest that retraction only applies to peer reviewed literature, whereas others extend the term to cover preprints. In the latter case the sense of the term is used similarly to 'recalled.'

In some instances, retraction is categorized according to the reasons for retraction and in other instances categorized via the source of retraction. In these instances, we found variation in the definition of retraction and questions regarding the authority to retract. When categorized using reason for retraction, the term covers classes of scientific offenses such as fabrication, falsification, plagiarism, or gross error. By contrast, categories that refer to the source of retraction include authors self-retraction, editors initiating a retraction, or third parties, such as research institutions, funders or government agencies writing a notice of retraction. However, those categories that speak to the source of the retraction raise the question of who is the legitimate retractor? Who needs to agree with the retraction? The editor and author and peer reviewers? What happens if these actors disagree? Who has the final word?

The definition of retraction shapes how stakeholders understand the role of retraction in scholarly publishing, particularly in terms of what a retraction is meant to communicate. Some strongly suggest that a retracted paper is so severe that it should never be cited. While others suggest that a retracted paper falls on a continuum of post-publication changes to the scholarly record.

Changing the Scholarly Record

Preserving the integrity of the scholarly record is seen by some as a valued end in itself. Responsibility for assuring the quality and integrity of the scholarly record is distributed amongst librarians, researchers and those in the publishing industry, but there is broad agreement that how to incorporate changes to the record is an urgent question to be addressed. In practice, this issue of integration is often framed in terms of tools to communicate a paper's status, and to help researchers, editors and decision-makers evaluate research integrity, relevance and quality.

However, in our stakeholder conversations the value of retracted research in the scientific record is contested. In some instances stakeholders discuss retraction as a sign of health--that the rate of retraction means science is working, and the publishers and editors are doing their job steward the scholarly record. Retraction notices with robust reasons for retraction allow for nuanced citations that add value to scholarship. Accordingly, some stakeholders suggest there is a value to 'negative knowledge,' or knowledge of previous error, or of what should be

professionally avoided. This perspective places a premium on transparency to suggest retractions should be made visible but retained as a matter of record, emphasizing the educational role of such cases. This broadly accords with the notion that science is a self-correcting system.

Others suggest, by contrast, the value communicated by retractions is limited, and retractions are either best sequestered, or removed from the literature entirely. This aligns more with the sense of retraction as 'wrong-doing,' as discussed above. On this account retraction is taken as a sign that the scholarly process doesn't work.

All of these themes concern how retraction and post-publication amendments are incorporated into the scholarly record. Some stakeholders desire robust, transparent retraction notices that would allow for robust and nuanced citation practices. Others, by contrast, think that retracted research should quite literally be removed from the scholarly record entirely, as if the compromised research never took place. Stakeholders in this camp have proposed, for purposes of research involving retraction, that there be a central, specialized database that quarantines retracted research, so as not to contravene the work of evidence synthesis.

The Harms of Retraction According to Stakeholder Discussions

Stakeholders broadly characterize the harms associated with retraction and continued citation of retracted research as distributed, but generally frame harms in terms of impact, primarily clustering around the harms associated with decision making that relies on invalid information; on wasted resources, characterized in terms of time, scientific labor and money; and the harm to science resulting from a betrayal of public trust. In these examples, the greater harm is to the prospect and reliability of scientific or scholarly research.

Stakeholders frame additional harms in terms of the emotional impact of retraction on researchers and editors where the retraction process, and science more generally, is characterized as a very 'human,' fallible, prone to mistakes, and conflicted. These emotional impacts are often framed as an impediment to retraction as well as evidence that the system must be fixed, particularly if we are to see retraction and other post-publication amendments as aspects of science as a 'self-correcting' system.

Research and its communication is subject to mixed motives, where editors and researchers' interests are shaped by pressures to publish, the pursuit of prestige and profit, and by legal constraints. These qualities impede efforts at transparent communication, perhaps preventing editors, researchers, and institutions from cooperating, and complicating a process frequently characterized as both resource intensive and time-consuming. In conversation, stakeholders also suggest that retraction is also emotionally taxing for both authors and editors, as well as their professional peer and social circles.

The Character of Reform According to Stakeholder Discussions

While opinions regarding the necessity of reform differ, there is strong agreement that the culture of research and scientific publishing must change. Salient examples of cultural change

include reforming citation practice, instituting broad changes to the education of researchers and editors, and redefining how retraction is both stigmatized and valued amongst researchers and within institutional settings.

Proposals to reform citation practice suggest that not all retracted research should be discarded, but rather incorporated through nuanced citations that denote why the retraction occurred, how the retracted research should be evaluated for particular purposes, and whether citation is done in positive or negative terms. For example, is a cited work acknowledging the retracted research, for purposes of scholarship, or is it citing the study as an example, ignorant of the problems with the research. In cases of correction, is there a way to distinguish between versions within the citation, or, for example, to cite aspects of a particular study that has been corrected. These issues of citation behavior hold implications for reforming impact factor schemes along such nuanced formats, but also how reference managers and citation review technologies are adopted as part of citation behavior.

Although retraction for honest error is a possibility, in stakeholder conversations retraction is also strongly associated with misconduct. To create positive incentives for engaging with retraction as a naturalized feature of science, rather than a pathology, many propose creating new incentives for valuing retraction as a feature of a researcher's conduct as well as a journal's prestige.

In conversation, some stakeholders propose new educational programs to train researchers and editors to understand the retraction process and evaluate retracted research. Often these proposals assume that retraction is a basic feature of science as a self-correcting system. Others suggest that education is needed to reform peer review, and to teach researchers about the consequences of retraction or to promote post-publication review. This coincides with proposed reforms designed to change how retraction is penalized, or whether it should be rewarded.

SYNTHESIZING THE PROBLEMS AND OPPORTUNITIES

Aligning Opportunity Pathways

The continued citation and use of retracted research is an 'ecosystem problem' for which there is no single solution. Continued citation and use is enabled by multiple coordinated aspects of the scholarly communications system and will require broad cooperation between stakeholder groups to produce the types of standards, agreements, and technologies needed to address the spread of retracted research in practice. A resolution to this issue will involve multiple forms of coordination and collaboration, identifying common norms, standardizing responsibilities, and aligning incentives to encourage cooperation amongst various stakeholder groups. This interactive work is threatened by contending definitions of the problem or if stakeholders face disincentives for participating in retraction processes.

In this context, understanding what ought to be done to address retraction and identifying recommendations that will be successfully adopted by stakeholders rests in part on broad

agreement about what is assumed to be possible. For example, as noted above, in the consultation process we identified a tension between those who favored the systematic reform of science and/or the scientific publishing industry and those who favored targeted, incremental reforms. Those that see the need for systemic reform tend to favor solutions premised on radical changes to the structure and practice of scientific publishing. By contrast, those who favor incremental change prefer mechanisms such as standards development, or adherence to cross-industry policies.

Questions of stigma and reputational impact may seem to detract from the central concern of this project and its focus on the continued circulation and citation of retracted research. Indeed, throughout the project this issue has been something of a fulcrum, where, in the opinion of some stakeholders focusing on the reputational threat seems misguided. However, the issue of stigma and associated impacts illustrates the outsized impact retracted research as a nested problem. Stakeholders who associate retraction with stigma and costs to career, reputation, and personal well-being, may be reluctant to adopt and implement broad reforms that strengthen the retraction process, even for issues of honest error.

In both the literature scan and in stakeholder consultations, we identified discrete pathways to address the continued spread of retracted research. These pathways were often characterized in terms of technological innovation. One frequently noted possibility is the incorporation of technologies to scan bibliographies for retracted research during submission of an article for publication, or during the peer review process, or as an aspect of the quality assurance pipeline. Another is a granular metadata scheme that includes fields for reasons for retraction, and a more sustained effort to include bidirectional links between retracted papers and retraction notices. Additional suggestions focus on the role of reference management software to notify researchers when articles have been retracted.

However, these proposed solutions are often coupled with acknowledged barriers to implementation. Reference checks add more work to an already taxed publishing system. Granular metadata and bidirectional linkages face cooperation hurdles between multiple sectors of the publishing ecosystem, and are costly to develop and implement. Reference management programs are unevenly employed by busy researchers whose reference collections are often treated as aggregative.

In addition to these barriers to implementation, we have also identified disagreement over the purpose, scope and ownership of common agreements and ecosystem wide standards. Where guidelines have been developed, stakeholders acknowledge adherence gaps. These gaps cluster around lack of common definitions, uneven implementation of existing standards, and divergent retraction policies at publishing houses, all of which create impediments to communication and collaboration.

Additionally, there is the perception that powerful stakeholders, such as publishers or universities, manipulate these gaps to their advantage, perhaps creating disincentives to widespread change or collaboration. To counter these dynamics, there is an urgency placed on

creating new incentives amongst stakeholders, and aligning incentives more generally, with the hope of creating stable pathways to collaboration. Some mechanisms for creating new incentive pathways include creating stronger standards amongst stakeholders, or the creation of centralized authorities to create or enforce norms.

Defining the Scale and Scope of the Problem

Mitigating the effects of retracted research will require strategies that involve multiple types of coordinated interventions. Multiple stakeholder communities and multiple areas of the scholarly publishing ecosystem are involved, and stakeholder groups are impacted by retracted research in differing ways. In our discussion above we have highlighted a number of possible ways to address the issue of retraction. In some cases what is needed is simply to disseminate and adopt existing practices, whereas in other cases, we identify innovation problems that will require the development of new standards, policies, or norms. In addition to these issues there is the persistent system level issue of how to incentivize change, build the will to address recognized issues in collaborative ways.

The continued circulation of retracted research is just one of many interrelated problems relating to retracted research. We recognize that there are a multitude of areas impacted by the circulation of retracted science, but which fall outside of the immediate scope of the study's recommendations. The reform of science, or of scholarly publishing falls outside of this scope, as does broad reform of the education of researchers, and editors. Similarly, we have not taken up in a direct way the organization of relationships between editors, funders, and research institutions. Each of these proposals involve a different focus, and specialized recommendations beyond our present focus.

Many of the frameworks and themes that we observed in the stakeholder consultation interviews speak to issues that fall outside of the scope of the RISRS project, which is focused narrowly on the citation and reuse of retracted work. Large issues regarding trust in science, or broad attitudes towards the best model of reform are important insofar as they identify background assumptions that shape questions of viability and implementation.

All of the problem and opportunity themes discussed above, and the proposed problem definitions, were vetted and discussed by stakeholders in the workshop process. Many of the recommendations below take up the overlapping problem definition regarding standards for retraction categorization, and visibility of retracted materials, to suggest recommendations in several areas within the scholarly communications ecosystem. We feel there is strong agreement in both problem assessment and diagnosis amongst the stakeholder and the literature that might be enhanced through further targeted work. Below we give some recommendations on what areas to target, the implementation actions that can be taken to build on each recommendation, and areas where further research can support the refinement of the proposed implementation areas.

RECOMMENDATIONS

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; and existing technologies that can be adopted; and for proposals for which there is existing or strong agreement.

LIST OF TOP LEVEL RECOMMENDATIONS

1. Prevent retractions from polluting the literature through the public availability of high-quality, consistent information about retractions.

2. Make retraction information easy to find and use by using clear and consistent display standards.

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

4. Develop best practices for coordinating the retraction process.

5. Educate stakeholders about retraction and pre- and post-publication stewardship of the scholarly record.

DISCUSSION OF THE RECOMMENDATIONS

Prevent Retractions from Polluting the Literature through the Public Availability of High-quality, Consistent Information about Retractions.

Over 95% of post-retraction citations in biomedicine do not demonstrate awareness that the cited item was retracted (Hsiao & Schneider, n.d.). Users' typical citation workflow may involve citing preprints, reusing downloaded PDFs, citing older works contained in their reference managers, and copying citations from their own or others' previous bibliographies (Bar-Ilan & Halevi, 2018; Davis, 2012). Among citation styles, only the American Medical Association (Christiansen et al., 2020), Vancouver/National Library of Medicine (Patrias & Wendling, 2018), and American Psychological Association (2019) styles provide explicit standards for citing retracted papers. 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.

Individual Recommendations for High-quality, Consistent Information about Retractions

1. Advocate for researchers to adopt and use citation software that flags retracted papers. (Zotero is a current example of such software, in partnership with Retraction Watch data.)

2. Support resources, standards, and sustainable funding sources to maintain databases that facilitate the public and unrestricted access to and dissemination of retraction statuses and retraction notices. At minimum, databases should feature APIs to track and disseminate retraction statuses.

3. Recommend that manuscript typesetters implement tools to identify and flag retracted papers in bibliographies as well as editorial workflows to ensure that citations show awareness of the retraction. (scite's Reference Check is an example tool in partnership with Retraction Watch data).

4. Develop additional citation styles and standards for indicating the retraction or correction status of a paper in text and in a bibliography.

5. Develop processes, agreements, and standards for retraction data interchange.

Implementation Actions for High-quality, Consistent information about Retractions

1. Advocate for improvements to existing software (e.g. EndNote, Mendeley, Paperpile, RefWorks, etc.) to flag retracted papers. Retraction Watch is a licensable source of good quality, domain-independent data about retracted papers.

2. Encourage producers of major style guides to add styles for retraction. Ensure that updated style guides are promptly implemented in Citation Style Language (n.d.).

3. Codify best practices for databases to facilitate the public and unrestricted access to and dissemination of retraction notices. Build off of the existing databases that do this. At minimum, databases should feature APIs to track and disseminate retraction statuses.
   a. Example: PubMed is a public database with an API that allows for unrestricted access to and dissemination of retraction notices, but only in biomedicine.
   b. Example: Retraction Watch is not restricted by topic but is limited to 600 results and does not have an API as of March 2021.

4. Adopt scite in publishing workflows and support scite expanding to other systems beyond Editorial Manager (Aries) and Manuscript Manager.

5. In implementing processes and standards for data interchange, develop automatic processes that distribute the dissemination of updates in a more systematic way, taking the burden of pushing out updates from publishers' workflows.

6. Develop model agreements license agreements for use between publishers and aggregators to make information flow. Expand on established agreements such as the National Library of Medicine's participation agreement for deposit (*Participation Agreements and Options*, n.d.).

7. Advocate for publishers to adopt Crossmark (*Crossmark*, n.d.) and to invest in maintaining content, including promptly registering updates with the Crossmark data service. Crossmark became free to Crossref members in March 2020 (Meddings, 2020).

8. Support Retraction Watch in developing an Application Programming Interface (API) and additional partnerships with data consumers.

Research Actions for High-quality, Consistent Information about Retractions

1. Editorial guidelines and resources devoted to publication ethics and integrity may play a role in publisher-level and/or journal-level differences. Compare COPE member journals to non-COPE journals, and investigate whether there is an information gap that could be addressed by some manner of communication or outreach between these two journal types.

2. Survey journals and researchers regarding their use of and adherence to COPE and ICMJE guidance, and design targeted case studies to identify the barriers to full adoption of the COPE and ICMJE guidelines, and whether or not stakeholders find these guidelines to be sufficiently detailed to be useful.

3. Gather evidence about the impact of different approaches to the retraction process. For instance, which is a more effective strategy for addressing the issue of timeliness: retracting as an immediate, first step, and then providing reasons later; or, providing reasons for retraction at the same time as retracting?

4. Examine variation in publishing policy and process through a series of synthetic case studies. This could help distinguish adherence (e.g., non-COPE members) versus compliance (e.g., COPE members not following the guidelines) to COPE guidelines.

Make Retraction Information Easy to Find and Use by Using Clear and Consistent Display Standards.

Information about retraction needs to move across different industry information providers (publishers, abstracting & indexing, scholarly search engines, etc.). However, currently this

need is challenged by non-robust dissemination, inconsistent information, and inconsistent presentation of retraction status information (Schmidt, 2018; Suelzer et al., 2020; Wright & McDaid, 2011).

Shared standards amongst publishers are necessary, but currently no industry-wide standards standardize retraction information or its visibility. The best existing guidelines, from COPE (COPE Council, 2019) and the (International Committee of Medical Journal Editors, 2019) (ICMJE) (International Committee of Medical Journal Editors, 2019), 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 (*COPE Members*, n.d.; International Committee of Medical Journal Editors, n.d.), previous research has found that publishers do not uniformly adhere to COPE and ICMJE recommendations (Balhara & Mishra, 2014; Bilbrey et al., 2014; Snodgrass & Pfeifer, 1992). Additionally, more consistent display standards are needed, particularly regarding uniformity in landing pages (Suelzer et al., 2020).

Individual Recommendations for Clear and Consistent Display Standards

1. Support and motivate stakeholders to consistently adopt and follow the recommendations from COPE and the ICMJE for managing retracted articles and retraction notices.

2. Translate the COPE and ICMJE guidelines into frameworks and checklists that can be adopted, scoped to the needs of multiple stakeholders groups.

3. Expand and clarify existing guidelines in order to enhance their usability and appropriateness for multiple stakeholder groups.

4. Develop a recommended practice or standard for how post-publications amendments are displayed by publishers. Incorporate the existing COPE recommendations.
   a. Rename each retracted article so that its title is clearly prefaced by 'Retracted'.

Implementation Actions for Clear and Consistent Display Standards

1. Organize a working group and standing committee as a cooperative effort between the National Information Standards Organization (NISO) and COPE to develop a recommended practice or standard for how retractions/withdrawal should be displayed on websites. Model standards development on the Recommended Practices for the Presentation and Identification of E-Journals (PIE-J) (*NISO RP-16-2013 PIE-J: The Presentation & Identification of E-Journals*, n.d.).

2. Advocate for the adoption of title update procedures for retracted articles to include 'Retracted' directly in title.

3. Develop frameworks to implement with specific stakeholder communities, building off of the following framework from (J. Schneider et al., 2020) which interprets the COPE and ICMJE guidelines.
    a. All search results for the title of the retracted article should also return the retraction notice.[3]
    For retracted articles on full-text sites:[45] (COPE Council, 2019)
        1. Each article landing page, full-text HTML article, and full-text PDF article should have a phrase indicating the retraction status (such as "retracted," "withdrawn," etc.) or a watermark indicating the retraction status.
        2. Each landing page, full-text HTML article, and full-text PDF article should have a computer-actionable link to the retraction notice.

    b. For retraction notices in full-text sites:[6]
        i. The retraction notice should appear in Table of Contents for the issue in which it appears, with a designated page number.

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[3] COPE 2019 on search: "The retraction should appear on all online searches for the retracted publication."

[4] COPE 2019 on visibility of retracted articles: "Retracted articles should be unmistakably identified as such in all online sources (eg, on the journal website, on the original article, and any bibliographic databases). Journals are responsible for ensuring that retractions are labelled in such a way that they are identified by bibliographic databases and should also include a link to the retracted article. The retraction should appear on all online searches for the retracted publication." And: "Retraction notices should be published in all versions of the journal (ie, print and/or online)."

[5] ICMJE on retractions "Expressions of concern and retractions should not simply be a letter to the editor. Rather, they should be prominently labelled, appear on an electronic or numbered print page that is included in an electronic or a print Table of Contents to ensure proper indexing, and include in their heading the title of the original article. Online, the retraction and original article should be linked in both directions and the retracted article should be clearly labelled as retracted in all its forms (Abstract, full text, PDF). Ideally, the authors of the retraction should be the same as those of the article, but if they are unwilling or unable the editor may under certain circumstances accept retractions by other responsible persons, or the editor may be the sole author of the retraction or expression of concern. The text of the retraction should explain why the article is being retracted and include a complete citation reference to that article. Retracted articles should remain in the public domain and be clearly labelled as retracted."

[6] COPE 2019 on retraction notices:
"Notices of retraction should:
• Be linked to the retracted article wherever possible (ie, in all online versions)
• Clearly identify the retracted article (eg, by including the title and authors in the retraction heading or citing the retracted article)
• Be clearly identified as a retraction (ie, distinct from other types of correction or comment)
• Be published promptly to minimise harmful effects
• Be freely available to all readers (ie, not behind access barriers or available only to subscribers)
• State who is retracting the article
• State the reason(s) for retraction
• Be objective, factual and avoid inflammatory language."

      ii.   The heading of the retraction notice should include the phrase 'retraction notice' and the title of the retracted article.

      iii.   The textual content of the retraction notice should state authorship, reason for retraction, and formally cite the retracted article.

      iv.   Each landing page, full-text HTML notice, and full-text PDF notice should have a computer-actionable link to the retracted article.

c. For database records for retracted articles:
      i.   A phrase indicating the retraction status, such as 'retraction,' 'retracted,' or 'withdrawn' should appear in the article record.
      ii.   The article record should have a computer-actionable link to the retraction notice. This could link to the database's record for the retraction notice, or to the full-text retraction notice.
      iii.   The article record has sufficient bibliographic information to retrieve the retraction notice.

d. For database records for retraction notices:
      i.   The phrase 'retraction notice' should appear in the text of the notice record.
      ii.   The notice record should have a computer-actionable link to the retracted article. This could link to the database's record for the retracted article, or to the full-text retracted article.
      iii.   The notice record has sufficient bibliographic information to retrieve the retracted article.

Research Actions for Clear and Consistent Display Standards

1. Examine the difference between COPE member journals vs. non-COPE journals, and consider whether there is an information gap that could be addressed by some manner of communication or outreach. Editorial standards and resources devoted to publication ethics and integrity may play a role in publisher-level and/or journal-level differences.

2. Survey journals and researchers regarding their use of and adherence to COPE and ICMJE standards, and design targeted case studies to identify the barriers to full adoption of the COPE and ICMJE guidelines.
   a. Develop focus groups to determine whether stakeholders find these guidelines to be useful in navigating the retraction process.
   b. Examine the retraction rate by journal, comparing COPE member journals vs. non-COPE journals to test whether implementation of COPE guidelines are sufficient or if there are other best practices that are required.

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 (Balhara & Mishra, 2014; Budd et al., 1998; Moylan & Kowalczuk, 2016). People using retracted science and evaluating authors of retracted science demand additional context about retraction to both clean up the literature and to disincentivize misconduct (Wager & Williams, 2011). Concerns about possible reputational damage and the risk of litigation and can disincentivize the use of more fine-grained distinctions about reasons for retraction (Tourish & Craig, 2020).

Individual Recommendations for Taxonomy & Metadata

1. Develop a taxonomy of retraction categories and corresponding metadata standards in tandem.

2. Host, curate, and maintain the taxonomy and metadata standards on a discoverable website with a formal home, based in an industry standards organization such as NISO or STM.

3. Build support and influence via adoption by highly visible organizations that will endorse and adopt the taxonomy and metadata standards. Then support and motivate other stakeholders to adopt them.

4. Identify additional areas for future taxonomies or nomenclature standardization, such as machine readable formats for reasons for retractions.

Implementation Actions for Taxonomy & Metadata

1. One outcome of the stakeholder workshop is the formation of a COPE working group to develop a taxonomy of retraction categories.

2. Based on the developments of this working group, we suggest that COPE partner with other other organizations, such as NISO or STM, to steward the development of this taxonomy as a more commonly adopted standard. COPE can provide ethics-related guidance and resources to publishers and editors, but if this taxonomy is to be broadly adopted, it must include wide-ranging input from a greater diversity of stakeholders in the scholarly publishing ecosystem. A standards organization would be well positioned to facilitate that process.

3. Integrate the taxonomy of retraction categories into existing versioning systems (e.g. for DOI incrementing, Crossmark amendments, etc.).

4. Support the use of persistent identifiers throughout the publishing ecosystem to enable audit-like functions to track amendments (Barbour et al., 2017). Build off of the F1000 model: "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." (*FAQs*, n.d.)

Research Actions for Taxonomy & Metadata

1. Evaluate the utility and impact of the COPE-developed taxonomy, once developed. In particular, identify any barriers to adoption.

2. Researchers should carefully track and document the standards-setting processes around the taxonomy of retraction categories/classifications. Standards setting processes are critically understudied, particularly related to their institutionalization in contexts for which there is little agreement or no strong responsible agent.
Crucial questions to consider include:
   a. How do the standards meet the various usability expectations of the stakeholder communities?
   b. How will the standards be implemented?
   c. How is the standard disseminated?

Develop Best Practices for Coordinating the Retraction Process.

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 (Hsiao & Schneider, n.d.). 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 the complexity of coordination amongst authors, co-authors, editors, and in some cases institutions may present complex logistical problems. 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 suggest that efforts to innovate retraction processes in this nexus—between institutions, publishers/editors, funders and researchers/editors—are often hampered by perception 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.

Individual Recommendations for Coordinating the Retraction Process

1. Develop best practice guidelines for coordination between institutions, publishers, funders and researchers.

2. Clarify best practices and guidelines for journals, authors and institutions to efficiently coordinate and address retractions related to figures, data sets, and data represented in images.

3. Provide recommendations to streamline the retraction process with respect to institutions and sponsoring agencies.
    a. Offer 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.
    b. Publishers should reserve the right to retract in legal agreements with authors.[7]
    c. 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.
    d. Create a workflow template for starting a retraction inquiry and adopt a checklist of requisite information for a retraction notice. Encourage journal editors and institutions to use the template and checklist to coordinate and communicate about the retraction inquiry.

Implementation Actions for Coordinating the Retraction Process

1. Revise current COPE guidance.
    a. Form a working group to recommend workflows for retractions and amendments related to figures and images.
    b. Clarify guidelines and workflows for expediting retractions and other amendments if the authors agree with or request retraction, or if a retraction is requested following an institutional misconduct investigation.

2. Form a cross-association working group to examine the coordination of retraction processes and to identify where retraction can be anchored in institutional policies. Membership should be drawn from COPE, the Association of Research Integrity Officers (ARIO), STM, and NISO. This is particularly timely as COPE is in the process of expanding its membership to include institutions.

3. Support the development of research data ethics guidelines through the FORCE11 Working Group on Research Data Publishing Ethics (*Research Data Publishing Ethics*,

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[7] COPE 2019: "Journals' instructions for authors should explain the journal's policies on publication ethics and describe the circumstances under which articles might be retracted. This information should be incorporated into author agreements and brought to the authors' attention."

2020), in collaboration with COPE. Work towards the adoption of the guidelines when they become available.

4. Support COPE initiatives to develop workflows that incorporate standardized retraction forms.
   a. Refine the European Association of Science Editors (EASE) standardized retraction form (European Association of Science Editors, 2015).
   b. Develop workflows to incorporate this form.
   c. Translate the form and workflow template/guidance into many languages to facilitate broad dissemination to a global use group.
   d. Incorporate workflow and template guidance into the COPE flowchart library which is already commonly used and referenced by editors and publishers.

Research Actions for Coordinating the Retraction Process

1. Examine potential institutional pathways for universities to implement guidelines and protocols for evaluating a researcher's record of retraction and post-publication amendments. Consider how to integrate best practice guidelines into research integrity policies and procedures so that retractions are not dealt with completely 'ad hoc'.
   a. Examine institutional pathways to naturalize researchers engaging in retraction to clean up the literature, and without penalty for honest error.
   b. Examine institutional pathways to strengthen negative incentives for misconduct that result in a retraction.

2. Develop comparative case studies to understand the legal environment for retraction, which sits in a complex nexus between publishers, researchers, and institutions. Develop governance and policy guidelines to facilitate where possible greater coordination between journals, institutions and other stakeholders such as funders and government agencies.

3. Research the impact of retractions on individual and institutional reputations. Develop case studies that support the development of best practice guidelines, especially for retractions involving students, contributing scholars, early career researchers, and promotion and tenure review.

4. Research the efficacy and usability of post-publication amendments for use in producing evidence synthesis products such as systematic reviews. Identify the evidence synthesis community's needs and requirements for post-publication amendments.

5. Determine whether differences in citation style guidelines and reference managers impact citation of retracted papers.

6. Investigate how to create reporting conduits that protect privacy but disincentivize the threat of retraction in academic infighting, personal vendettas and other forms of 'data

bullying.'

7. Research the role of funding agencies in guiding recipients' institutional policy. Develop models guidance and best practices.

8. Develop case studies of university researchers navigating the retraction process, particularly for cases of honest error, building off of (Hosseini et al., 2018). What are the social and institutional impediments to this process? For researchers based at universities, for example, the process of retracting a publication may involve a coordinated process between publishers and editors, multiple authors, and institutional officers, and in some cases lawyers. The legal, reputational, and financial negotiations and outcomes of these processes are complex, and this process potentially slows down retraction and often makes retraction expensive.

9. Investigate the costs associated with adopting innovations in the scholarly publishing ecosystem. Examine the barriers to stakeholder adoption and guidance of best practices and standard policies.

Educate Stakeholders About Retraction and Pre- and Post-Publication Stewardship of the Scholarly Record.

For researchers and editors there is a tension between the need to correct the literature and the need to preserve their reputations. 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 (COPE Council, 2019; Williams & Wager, 2013). 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.

Individual Recommendations for Educating Stakeholders

Researcher Education

1. Educate researchers on the value of retractions. Promote correct understanding of retraction, peer review, and publication ethics as part of Responsible Conduct of Research (RCR) Education.

2. Emphasize the need to correct publications as part of responsible data management and work to destigmatize the act of retracting articles.
   a. Develop an anthology of stories of honest retraction aimed at destigmatizing retraction amongst senior scientists. Retraction Watch's "doing the right thing" columns (*Doing the Right Thing*, n.d.) and *The Winnower*'s stories of both honest retraction and misconduct are a model in "letting it all hang out" (Baker et al., 2014; Linger & Graham, 2014; Palestis et al., 2014; Stapel, 2014).

      b. Move away from inflammatory language associated with misconduct. Naturalize a more neutral tone for retraction inquiry and reportage.

3. Develop retraction-focused best practice modules to be integrated into RCR education.
      a. Develop pedagogical materials for use in broader ethics and professionalization training.This should include materials on different reasons for post-publication changes to publications.
      b. Make materials available in open education platforms under licenses suitable for translation and reuse, to encourage multilingual availability.

Authors

1. Educate authors about their duties and responsibilities related to retraction and post-publication amendments.
      a. Authors have a responsibility to evaluate and assess the references in their bibliographies. In particular:
            i. Authors are expected to cite and reference reliable papers in good standing.
            ii. Authors are expected to provide correct and complete reference details, and to respond to questions about errors/omissions in bibliographies in manuscripts at the pre-press stage.
      b. 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.

Editorial Education

1. Build awareness of existing COPE resources and retraction best practices among editors, preprint managers, peer reviewers, and publishers.

2. Encourage efforts to destigmatize the decision to retract articles, and educate editors about policies regarding previously retracted work.

Implementation Actions for Educating Stakeholders

1. Develop a working group to develop case studies aimed at researchers and to be used in RCR education.

2. Develop best practice educational modules that address the stigma associated with retraction.

3. Where necessary develop educational materials to educate editors, preprint managers, peer reviewers, and publishers about honest inadvertent serious errors that may require retraction. Develop accompanying strategies for dissemination of this material.

4. Establish indexing guidelines and standards that support authors in identifying authoritative sources for checking citations, beyond Retraction Watch and PubMed. The ICMJE guidelines note that: "Authors are responsible for checking that none of the references cite retracted articles except in the context of referring to the retraction. For articles published in journals indexed in MEDLINE, the ICMJE considers PubMed the authoritative source for information about retractions."[8] Develop a working group to take up the expansion of these recommendations more broadly, beyond medicine.

5. Encourage transparent policies around editorial consideration of previously retracted work, and avoid undue bias toward authors of retracted work in the editorial process.

Research Actions for Educating Stakeholders

1. Survey and evaluate existing models for educating researchers about the publication process. As an outcome of this research, develop educational materials that address retraction and best practices in educating researchers about navigating the scholarly communications ecosystem.

2. Research and develop best practice guidelines for managing the impact of retractions on individual and institutional reputations, especially those of students, contributing scholars, and early career faculty.
   a. Guidelines should specifically address career development for students, contributing scholars and early career researchers. Guidelines should address issues of advancement and promotion at all stages of academic careers, including the tenure review process.
   b. Guidelines should illustrate best practices for working with researchers that self-retract for reasons of error.
   c. Guidelines should address whistleblowing activity with appropriate sensitivities to issues of punishment, retribution. Careful attention should be placed on differential power dynamics involved in the student-advisor relationship, postdoctoral researcher and sponsors, and lab manager.

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[8] Full ICMJE Guidelines: "Authors are responsible for checking that none of the references cite retracted articles except in the context of referring to the retraction. For articles published in journals indexed in MEDLINE, the ICMJE considers PubMed the authoritative source for information about retractions. Authors can identify retracted articles in MEDLINE by searching PubMed for "Retracted publication [pt]", where the term "pt" in square brackets stands for publication type, or by going directly to the PubMed's list of retracted publications."

3. Establish a research program to examine the role of peer review in retracted research. Synthesize the literature on recommendations for reforming peer review and investigate by discipline.

4. Investigate how disciplinary and professional societies can incentivize authors to steward their publications, making post-publication changes when fundamental errors are identified.

5. Research why some editors and publishers don't use COPE resources. Develop and disseminate educational materials to editors and journals that focus on education for editors. Existing materials developed by COPE are available for membership, but may not be widely distributed beyond COPE membership. Develop a working group to evaluate and build upon COPE resources for editors, and create supplemental case studies to illustrate best practices. These resources can be utilized in the professional development of editors, as well as in formal training programs in publishing.

6. Investigate the resources and capacity that editors have to engage in retraction processes. Examine the role of publishers and editorial boards in developing appropriate procedures, policies and capacities to support editors in retraction processes.

7. Examine the role of stigma in the perception of retracted research. Analyze the institutionalization of norms supporting the destigmatization of retract articles from the authors' and editors' standpoints. Consider how to develop and encourage the adoption of transparent policies around consideration of previously retracted work, and avoid undue bias toward authors of retracted work in the editorial process.

8. Determine the rate at which retractions are inappropriate according to the guidelines; this is a topic that has received only limited study (Huh et al., 2016).

CONCLUSIONS

The goal of the RISRS project is to develop a research and implementation model for reducing the spread and continued citation of retracted research. We hope you will provide feedback and help us refine it!

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 publishing. 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 to focus our attention, and to anchor recommendations in the terrain of the scholarly communications ecosystem.

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.

In conclusion we briefly cover some aspects of our implementation strategy, and describe ways to be involved in the collaborative development of this agenda.

Implementation Strategy
Throughout the RISRS project, we have created opportunities for synthesis at three levels to help to refine the problem, outlined incentives for broad adoption of change strategies, and defined a series of cross-sectoral implementation strategies. We hope that by outlining multiple strategies we encourage stakeholders to address the continued citation and use of retracted research through collaboration.

There are multiple possible barriers to successful adoption and implementation of our proposed recommendations and accompanying implementation and research agenda. Stakeholders face disincentives related to perceptions of stigma, risk and litigation. They equally face costs associated with investment and sustainability. In our examination of problems and opportunities we identified areas of broad agreement, as well as disagreements over issues such as the nature of science, the purpose of the scholarly record, and the role of retraction in the research ecosystem. In spite of these potential barriers, we suggest that possible solutions to the problem of the citation of retracted research will require agreement regarding the horizon of possibilities, but perhaps not exact agreement over the direction of travel

We have built recommendations out what areas of agreement we could identify. No single community will solve the issue of the continued citation of retracted research. We have accordingly outlined multiple implementation actions for adopting and refining the recommendations in the near term, targeting areas where cross-sector collaboration and cooperation is possible across stakeholder groups, despite having different, or even at times, conflicting interests.

These recommendations have been co-constructed with stakeholders. In a similar way we propose the implementation agenda is best conceived of as action *with* stakeholders. The action-oriented, iterative development of the recommendations and implementation actions constitute areas of future research that will support a process of co-production of research and implementation action. We do not, however, see this as the end of the process, but rather as a stage in the further co-development of actionable implementation strategies that cut across stakeholder groups. The actions produced by the implementation of our proposed recommendations are areas of anticipated future research.

Call to Action
This document is still a draft of the final version, and we are actively soliciting feedback from stakeholders. The recommendations below are being circulated for further refinement (e.g. through the draft white paper you are now reading) with the aim of producing a final white paper

in May 2021. The RISRS team will continue to solicit feedback from across the scholarly communications ecosystem through presentations this spring to the Society for Scholarly Publishing and other groups.

We welcome your feedback to refine the recommendations and the implementation and research agenda. For instance, you might help form a professional working group to further develop or refine these recommendations; present about retraction and related issues at professional and academic meetings; take on an implementation or policy project; or outline further research to be conducted. Based on your feedback we will continue to engage in the work of synthesis as we add to or refine recommendations.

The proposed schedule for ongoing feedback is:

Mar 14 Version 2 circulated to stakeholders
Mar 29 Deadline for comments, suggestions

Apr 12 Version 3 circulated to stakeholders for last look
Apr 26 Deadline for comments, suggestions

May 3 White Paper completed

We invite you to provide additional feedback to help shape the scope of the recommendations. This version is being circulated publicly as a preprint to maximize the feedback we receive. We would appreciate feedback in the Google Docs linked from the project website https://infoqualitylab.org/projects/risrs2020/ or by email to jodi@illinois.edu.

LIST OF APPENDICES

Appendix A: RISRS Project Outcomes to Date
Appendix B: Problems and Opportunities Dataset
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Appendix D: Stakeholder Consultation Process

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Appendix A:
RISRS Project Outcomes to Date

The RISRS Team

To accompany Reducing the Inadvertent Spread of Retracted Science: Shaping a Research and Implementation Agenda, Draft v2
March 13, 2021

I. **Websites**
   A. Project website
      https://infoqualitylab.org/projects/risrs2020/
   B. RISRS collection of data & documents in the IDEALS institutional repository
      https://www.ideals.illinois.edu/handle/2142/108359
   C. Working bibliography
      https://infoqualitylab.org/projects/risrs2020/bibliography/

II. **Post-Workshop Dissemination Activities:**
   ● Jodi Schneider. "The problems of post-retraction citation - and mitigation strategies that work," NIH Bibliometrics & Research Assessment Symposium 2020, https://www.nihlibrary.nih.gov/services/bibliometrics/bibSymp20, October 9. Recording of the talk:
   https://www.youtube.com/watch?v=nSMheuwAKA8&feature=youtu.be&t=38m51s
   ● Randi Proescholdt & Jodi Schneider. Retracted Papers with Inconsistent Document Type Labeling in PubMed, Scopus, and Web of Science. SIGMET poster, presented October 22, 2020 at the METRICS 2020 workshop at ASIS&T 2020. http://jodischneider.com/pubs/sigmet2020.pdf
   ● Jodi Schneider. "Continued citation of bad science and what we can do about it," Invited talk, Center for Computational & Data Science, Syracuse University School of Information Studies, Friday February 19, 2021.
   ● Caitlin Bakker, Hannah Heckner, Randy Townsend, Jodi Schneider. "Connecting the dots: A cross-industry discussion on retracted research," Part of Misinformation and truth: from fake news to retractions to preprint, NISO Plus 2021: February 25, 2021. Recording for subscribers via https://nisoplus21.sched.com/event/2cffe14c6663f2286055a597869970a1 Slides archived in https://nisoplus.figshare.com
   ● Annette Flanagin, Hannah Heckner, Deborah Poff, John Seguin, Jodi Schneider. "A cross-industry discussion on retracted research: Connecting the dots for shared responsibility," Society for Scholarly Publishing 43rd Annual Meeting. May 24-27, 2021 (date TBD)

III. **Completed Research**
   ● Yuanxi Fu and Jodi Schneider. Towards knowledge maintenance in scientific digital libraries with keystone citations. In JCDL '20: Proceedings of the

ACM/IEEE Joint Conference on Digital Libraries in 2020, August 2020, Pages 217–226, doi:10.1145/3383583.3398514
- Jodi Schneider, Di Yi, Alison M Hill, Ashley S Whitehorn. Continued Citation of a Fraudulent Clinical Trial Report, Eleven Years after it was retracted for Falsifying Data. Scientometrics. Volume 125, issue 3, December 2020, pages 2877–2913 doi:10.1007/s11192-020-03631-1
- Yuanxi Fu, Jodi Schneider, and Catherine Blake. "Keystone Citations for Constructing Validity Chains among Research Papers." Sci-K 2021. To appear in the Companion Proceedings of The Web Conf 2021. http://jodischneider.com/pubs/scik2021.pdf

IV. **Work in Progress**
- This white paper with the recommendations & context
- Hsiao, T.-K., & Schneider, J. (n.d.). Continued use of retracted papers: Temporal trends in citations and (lack of) awareness of retractions shown in citation contexts in biomedicine. https://osf.io/5z2n4/?view_only=c7e1c5ecb59f4b81962700a298dc0326 (To be submitted to QSS)
- Background Policy brief aimed at the White House Office of Science & Technology Policy
- Information briefs of recommendations to be disseminated to relevant professional organizations
- Articles to write
  - Literature review (targeting ASIST)
  - GW Journal of Ethics in Publishing
  - Information Services and Use
- Proposals for future research
- Collaborations to start achieving the recommended outcomes

Appendix B:
Problems and Opportunities Dataset

Nathan Woods, Yoss Arianlou, Yee Yan (Vivien) Yip, and the RISRS Team

To accompany Reducing the Inadvertent Spread of Retracted Science: Shaping a Research and Implementation Agenda, Draft v2
March 14, 2021

The 143 items below were used from the scoping review; for full references see the scoping review bibliography "List of 162 Central Items From the Scoping Review of Empirical Research (up to April 2020)", pages C4-C16

Ajiferuke (2020)
Al-Ghareeb (2018)
Almeida (2016)
Alryalat (2020)
Amos (2014)
Aspura (2018)
Atlas (2004)
Ayodele (2018)
Azoulay (2015)
Balhara (2014)
Balhara (2015)
Bar-Ilan (2017)
Bar-Ilan (2018)
Bilbrey (2014)
Bolboaca (2019)
Bornemann-Cimenti (2016)
Bozzo (2017)
Budd (1998)
Budd (1999)
Budd (2011)
Budd (2016)
Campos-Varela (2019)
Campos-Varela (2019)
Carey (2016)
Casadevall (2014)
Cassao (2018)
Chambers (2019)
Chauvin (2019)
Chen (2013)

Chen (2018)
Cox (2018)
Dal-Ré (2020)
Damineni (2015)
Davis (2012)
de Almeida (2016)
Decullier (2013)
Decullier (2014)
Deculllier (2018)
Dinh (2019)
Duggar (1995)
Elango (2019)
Elia (2014)
El-Tahan (2019)
Faggion (2018)
Fanelli (2013)
Fanelli (2015)
Fang (2011)
Fang (2012)
Foo (2011)
Foo (2014)
Friedman (1990)
Fulton (2015)
Furman (2012)
Gasparyan (2014)
Greitemeyer (2014)
Greitemeyer (2015)
Grieneisen (2012)
Hagberg (2020)
Halevi (2020)
Hamilton (2019)
He (2013)
Hesselmann (2019)
Hosseini (2018)
Hu (2017)
Huh (2016)
Hwang (2018)
Inoue (2016)
Jan (2018)
Jones (2008)
Karabag (2016)
Kim (2019)
Kochan (1992)
Korpela (2010)

Kuroki (2018)
Li (2018)
Lu (2013)
Madlock-Brown (2015)
Markowitz (2016)
Mena (2019)
Mistry (2019)
Molckovsky (2011)
Mongeon (2016)
Mott (2019)
Moylan (2016)
Nair (2020)
Nath (2006)
Neale (2007)
Neale (2010)
Nogueira (2017)
Pantziarka (2019)
Parrish (1999)
Peterson (2013)
Pfeifer (1990)
Pfeifer (1992)
Qi (2017)
Quan-Hoang (2020)
Rabow (1999)
Rada (2005)
Rada (2007)
Rai (2017)
Rapani (2020)
Redman (2008)
Resnik (2013)
Resnik (2015)
Ribeiro (2018)
Roe (2019)
Rosenkrantz (2016)
Rubbo (2019)
Samp (2012)
Schmidt (2018)
Shema (2019)
Shuai (2017)
Silva (2017)
Singh (2014)
Snodgrass (1992)
Souder (2010)
Stavale (2019)

Steen (2011)
Steen (2011)
Steen (2011)
Steen (2012)
Steen (2013)
Stern (2014)
Stretton (2012)
Suelzer (2019)
Tourish (2020)
Trikalinos (2008)
Tripathi (2018)
Van Der Vet (2016)
Wager (2011)
Wang (2017)
Wang (2018)
Wasiak (2018)
Whitely (1994)
Wiedermann (2018)
Williams (2013)
Woolley (2010)
Woolley (2011)
Wray (2018)
Wright (1991)
Wright (2011)
Yan (2016)
Zhang (2013)

Appendix C:
Literature Scoping Review Methods and Intermediate Results

Randi Ellen Proescholdt, Jodi Schneider, and the RISRS Team

To accompany Reducing the Inadvertent Spread of Retracted Science: Shaping a Research and Implementation Agenda, Draft v2

March 14, 2021

Inclusion Criteria

We aimed to identify as many items as reasonably possible that contained original, empirical data about retraction. Specifically, we sought items that met the following inclusion criteria:

In order to be included in the final review, a publication must:
-Include original, empirical data about retraction, retracted articles, retraction notices, or closely related topics (e.g. retraction-related policies, citations of retracted articles, suggestions for reforms related to retraction). Systematic reviews of retracted publications are included when they contain original findings resulting from analysis or synthesis of the existing literature; if literature is assembled without analysis, we do not consider the review to contain original, empirical data.

-Be "about" retraction: a publication must directly study retraction, retracted articles, retraction notices, or closely related topics (e.g. retraction-related policies, citations of retracted articles, suggestions for reforms related to retraction) and have findings, discussion, or results directly relating to these topics. For example, studies about scientific misconduct are not our focus, but those studies we find that present original data about retraction as part of their discussion about scientific misconduct are included.

-Have findings relevant to retraction in general, not just relevant to a particular example or case study. Case studies are included only when the cases discussed are used as ways of exploring broader topics within retraction.

Search Strategy

Our database searches aimed to:

-*Include* all types of scholarly publications likely to contain original, empirical research

-*Include* publications from any language. We seek to translate publications not in English as needed to ascertain their relevance to the review

-*Exclude* retracted articles and retraction notices

-*Exclude* news articles, correspondence, editorials, letters, or comments*

*These publications are not within the scope of our search because they would greatly increase the number of publications to be screened and many do not contain empirical data. However, we are aware that these publications sometimes do contain original, empirical data. If these publications came to our attention by means other than our search (e.g., a news article we came across because it is commonly cited) and they met our inclusion criteria, they were considered for the final review.

We searched three databases—PubMed, Scopus, and Web of Science—on July 19, 2018, and again on April 21, 2020. See (Scoping Review Database Search Strings). We aimed to identify as many items as reasonably possible that met our inclusion criteria.

Additional Search Method

Additionally, in June/July 2018, we used the citation- and text-based framework developed by Sarol, Liu & Schneider (2018) to retrieve other relevant articles that cited or were cited by some of the other articles included in our review, and had related terminology in their title and abstract. Five publications were used as the "seed articles" that were used to identify other potential articles of interest via Scopus (Budd et al., 1998; Chen et al., 2013; Grieneisen & Zhang, 2012; Hesselmann et al., 2017; Pfeifer & Snodgrass, 1990). We also screened previous ad-hoc bibliographies created from 2017-2019 during our team's informal reviews of retraction.

Title, Abstract, and Full-Text Screening

Results from each search were brought into our review software, EPPI-Reviewer, where they were deduplicated and screened against our inclusion criteria in several stages. We removed duplicates using EPPI-Reviewer's deduplication function, as well as manually reviewing the citation information. Then we screened the remaining items to identify those that we determined to meet our criteria. First one person (JS) reviewed the titles of the retrieved items to eliminate those that we felt confident did not meet our inclusion criteria. Those that likely met our criteria or were uncertain were abstract screened by two people, and reconciled. We eliminated articles with abstracts that clearly indicated the item was not within the scope of our review. Finally, we full-text screened the articles that we had determined might meet our criteria based on their abstracts. During full-text screening, we read each article and coded it as "include" or "exclude"; subcategories were also assigned to indicate provisionally included articles (e.g., those with limited empirical data) and reasons for exclusion (e.g., those not related to retraction, or those not containing original research). At the abstract and full-text steps, articles were reviewed by at least two team members, and discussed when there was disagreement so that consensus was reached.

Categorization Process

We have placed a number of the articles included in the review by a variety of categories. The core 162 articles currently included in the review can be found on the project website (https://infoqualitylab.org/projects/risrs2020/bibliography/), and can be filtered by some of the

categories we have assigned them—method, artifact, and data source—as well as other traditional methods of filtering such as publication type. In addition, within EPPI-Reviewer, we have categories related to findings of papers, suggested problems and reforms, the stakeholder roles that are addressed, and suggestions for future work. Within these categories are many subcategories. However, these categorizations are rough and need refining. We are currently in the process of developing crisper and more robust categories to help with the analysis and comparison of the diverse set of publications included in this review.

Scoping Review Database Search Strings

The following search strings were used:

Search conducted on July 19, 2018

PubMed (Legacy) (216 results):

((retracted articles[Title/Abstract] OR retracted publications[Title/Abstract])) OR ("Retraction of Publication as Topic"[MeSH] NOT"Comment"[PT] NOT "News"[PT] NOT Letter[PT] NOT Editorial[PT] NOT "Retracted Publication"[PT] NOT "Retraction of Publication"[PT] NOT "Published Erratum" [PT])

Scopus (730 results)

(TITLE-ABS-KEY (retract* AND publication) AND NOT TITLE ("Retraction notice to") AND NOT TITLE ("Retraction to") AND NOT TITLE ("Erratum notice to") AND NOT TITLE ("Erratum to") AND NOT TITLE ("Retraction:") AND NOT TITLE ("Erratum:")) AND (EXCLUDE (DOCTYPE,"no") OR EXCLUDE (DOCTYPE,"ed") OR EXCLUDE (DOCTYPE,"er") OR EXCLUDE (DOCTYPE,"le") OR EXCLUDE (DOCTYPE,"pr") OR EXCLUDE (DOCTYPE,"tb"))

Web of Science (181 results)

 ((TS=(retract NEAR publication) OR TS=(retraction NEAR article))) AND DOCUMENT TYPES: (Article OR Abstract of PublishedItem OR Bibliography OR Biographical-Item OR Book OR Book Chapter OR Chronology OR Data Paper OR Discussion OR EarlyAccess OR Excerpt OR Item About an Individual OR Meeting Abstract OR Meeting Summary OR Proceedings Paper OR ReprintOR Review)

Refined by: [excluding] DOCUMENT TYPES: (RETRACTION OR RETRACTED PUBLICATION)Timespan: All years. Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED,IC.

Searches conducted on April 21, 2020 and February 10, 2021

PubMed (Legacy) (2297 results as of April 21, 2020; 2518 results as of February 10, 2021)

(retract*[Title/Abstract] AND (paper*[Title/Abstract] OR notice*[Title/Abstract] OR article*[Title/Abstract] OR publication*[Title/Abstract] OR misconduct[Title/Abstract]) OR "Retraction of Publication as Topic"[MeSH] NOT "Comment"[PT] NOT "News"[PT] NOT Letter[PT] NOT Editorial[PT] NOT "Retracted Publication"[PT] NOT "Retraction of Publication"[PT] NOT "Published Erratum" [PT])

Scopus (2040 results as of April 21, 2020; 2325 results as of February 10, 2021)

((TITLE-ABS-KEY (retract* W/15 publication) OR ABS (retract* W/15 article) OR ABS (retract* W/15 paper) OR KEY (retract* W/15 paper) OR TITLE (retract* W/15 paper) OR TITLE-ABS-KEY (retract* W/15 "notice") OR TITLE-ABS-KEY (retract* AND misconduct) AND NOT TITLE ("Retraction notice to ") AND NOT TITLE ("Retraction to"))) AND NOT TITLE ("Retraction notice to") AND NOT TITLE ("Retraction to") AND (EXCLUDE (DOCTYPE , "no") OR EXCLUDE (DOCTYPE , "ed") OR EXCLUDE (DOCTYPE , "er") OR EXCLUDE (DOCTYPE , "le") OR EXCLUDE (DOCTYPE , "pr") OR EXCLUDE (DOCTYPE , "tb")))

Web of Science (3989 results as of April 21, 2020; 4314 results as of February 10, 2021)

(TS=(retract* NEAR publication$) OR TS=(retract* NEAR article$) OR TS=(retract* NEAR paper$)) OR AB=(retract* NEAR notice$) OR TS=(retract* AND misconduct)

Refined by: [excluding] DOCUMENT TYPES: (RETRACTED PUBLICATION OR EDITORIAL OR CORRECTION OR PATENT OR LETTER OR RETRACTION OR NEWS OR CORRECTION ADDITION)

Timespan: All years. Databases: WOS, BIOABS, BCI, CABI, CCC, DRCI, DIIDW, FSTA, KJD, MEDLINE, RSCI, SCIELO, ZOOREC.

Search language=Auto

PRISMA diagram (placeholder - will be provided after search update complete)

List of 162 Central Items From the Scoping Review of Empirical Research (up to April 2020)

This list is also available in an interactive dynamic bibliography at https://infoqualitylab.org/projects/risrs2020/bibliography/ *which will include additional items when the screening for the February 2021 search update is completed.*

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Appendix D:
Stakeholder Consultation Process

Nathan D. Woods, M.T. Campbell, Jodi Schneider, and the RISRS Team

To accompany Reducing the Inadvertent Spread of Retracted Science: Shaping a Research and Implementation Agenda, Draft v2
March 14, 2021

Stakeholders engaged in the RISRS project have contributed to ongoing rounds of feedback, integration and dissemination, with the aim of introducing change into the scientific publishing ecosystem. Stakeholder dialogue and synthesis has been key to deriving a clear understanding of how retracted science is understood in different professional and sector domains. The RISRS team is developing an ecosystem map of concrete actions needed to support cross-sectoral collaboration, which will ultimately help identify pathways for effective implementation.

Stakeholder Consultation

Stakeholder consultation in the RISRS process plays a central role in identifying problems, possible solutions, and collaborative implementation strategies. Stakeholders were invited to engage with the project starting in July 2020. All stakeholders were invited on the basis of their professional expertise and roles in publishing, research, information technology, university and government. Stakeholders included funders, editors, peer reviewers/authors based at both universities and government research facilities, commercial and scholarly publishers, individual researchers, librarians, platform and database providers, university research integrity officers, science journalists, staff at professional organizations, and members of standards setting organizations.

Stakeholders were invited to participate in the RISRS project in multiple ways, and were given the choice to participate in an hour-long interview, to contribute an original position paper, to be included on the project website, and to participate in an online workshop series. These contributions were subsequently used in a variety of synthesis activities, including the design of the workshop, and the resulting white paper recommendations. Informed consent materials were subsequently sent to those who agreed to participate in an interview or attend the workshop.

Stakeholder Invitation Process

Stakeholder invitations were organized in three rounds, beginning with the formation of an advisory group starting in March 2019. Additional stakeholders were subsequently invited to participate starting in July 2020, following funding from the Alfred P. Sloan Foundation and Institutional Research Board approval, and adjustments to the workshop schedule as it moved

online. All stakeholders were invited to participate via an introductory email that included information on the general goals of the project and a link to the project website.

In the first round, stakeholders were invited on the basis of professional contacts, recommendations from the advisory board, and proposal review comments from the Alfred P. Sloan Foundation. The second round of targeted invitations were based on both advisory board recommendation, consulting available professional networks, and identifying people at relevant organizations via LinkedIn and organizational websites. Finally, in the third stage, invitees were selected through peer-nomination (snowball sampling).

Invitees were asked to participate broadly in the RISRS process, either through an interview, or participation in the workshop, or through the contribution of an original position paper (see Appendix: Workshop Invitation).

Advisory Board

The stakeholder invitation process is anchored in the role of an advisory board composed of leaders in the field of scholarly communication (see Table 5).

Table 5: RISRS Advisory Board Members by Role

Journal Editor: Annette Flanagin, Executive Managing Editor and Vice President, Editorial Operations, JAMA and The JAMA Network

Research Integrity Officer: C.K. (Tina) Gunsalus, J.D., Director, National Center for Professional & Research Ethics, University of Illinois at Urbana-Champaign.

Researcher: Daniele Fanelli, PhD, Fellow in Quantitative Methodology, Department of Methodology, London School of Economics and Political Science.

Journalist: Ivan Oransky, MD. Co-Founder of Retraction Watch & Editor in Chief of Spectrum

The advisory board helped identify and attract stakeholders from across diverse fields related to scholarly communication in several ways. First, the advisory board was tasked with helping to identify stakeholders who might participate in the project workshop, in the interview process, as well as those who might be consulted for specific or ongoing feedback. Second, as recognized leaders in their professional fields, board members have provided trusted feedback from different sectors in the scientific publishing ecosystem. Finally, the advisory board ensured that people with a diversity of perspectives were invited to participate.

Stakeholder Diversity

Broad inclusivity measures were built into the invitation of potential participants. Diversity of personal and professional experience was a key component of the advisory board selection process. Gender balance□—two of the four advisory board members are women, and includes

one mid-career and one senior professional—was a foundational aspect of this consideration. Additionally, the board was asked to consider further diverse inclusion criteria for enrollment. Our goal was to to include professionals from the global south, women, non-white, as well as women as potential stakeholders, and people from various career stages in their recommendations.

The project committed to ensuring that about half of our participants are women, and during the invitation process we attempted to send 50% of our invitations to women. In striving for racial and gender diversity in the project, we sought diverse leadership in scholarly communication by consulting members of a diversity of organizations, including:
- The Society for Scholarly Publishing's Diversity and Inclusion Task Force
- Association of Research Libraries: Senior Director of Diversity and Leadership Programs (Mark Puente)
- The Association of American University Presses Equity, Justice & Inclusion Committee
- The Workplace Equity Project

Invitations to stakeholders were sent in July of 2020 and this process concluded in late October of 2020 with the start of the workshop series. A second round of invitations to participate will begin in February of 2021, and will focus on consulting additional stakeholder roles that were identified as a result of the workshop. Stakeholders consulting in this round of interviews will also be invited to provide feedback on the evolution of the white paper, and implementation model.

Consultative Interviews

As part of the stakeholder synthesis process, interviews were structured to introduce participants into the project's larger engagement process, as well to consult stakeholders on their ideas, opinions, attitudes and perspectives of retracted research and its continued citation.

Interviewees for the project fall into two broad categories: those who participated in the workshop, and those who only participated in an interview. Interviewees in this second category also included people that could not attend the workshop (e.g. due to timezones), people with special perspectives, such as lawyers working in the publishing industry, or interviewees who had special organizational contexts, but not general knowledge or awareness of issues related to retracted research. Additionally, some stakeholders participated in the workshop, but declined an interview. During the interviews, stakeholders were interviewed on their experience with retracted research, their opinions and attitudes towards the variety of retractions, and the harms associated with retraction, as well as any perspectives or experiences that they might offer as related to retracted research, its continued citation, and the work of maintaining or correcting the scientific record. (See Appendix: Interview Questions)

Project Materials

To disseminate information about the project, the project team created a website providing information about the RISRS objectives and goals, and the names and roles of the RISRS

research team, advisory board, and workshop participants as they joined. Participant-contributed position papers were added to the website, and placed in IDEALS, an institutional repository maintained by the University of Illinois, Urbana-Champaign. These position papers, the team's preliminary research outputs, and workshop materials were made available to workshop participants in a Google Drive folder, with Word documents available on request.

Materials produced by the RISRS team in preparation for the workshop included: a searchable bibliography derived from the literature review; an initial summary of the literature, focused on continued citation of retracted papers and the quality and visibility of retraction notices; an analysis of metadata errors of retraction status in common databases; results of a thematic analysis of consultations with stakeholders, and a citation analysis. As the project develops, the project website (https://infoqualitylab.org/projects/risrs2020/) and the RISRS institutional repository collection (https://www.ideals.illinois.edu/handle/2142/108359) will be developed to act as a hub of continued engagement.

Workshop Process and Stakeholder Synthesis

An intensive three-day stakeholder workshop was built into the design of the RISRS project to facilitate active and engaged dialogue, cross-sector problem solving and collaboration.

Workshop Design for Moving Online

The proposal called for an in-person workshop to be held over a period of 1.5 days at the Big 10 Conference Center in Chicago. Due to the global pandemic, the proposed in-person workshop was converted to an online format. To preserve the original intention while adapting to the online medium, the workshop was re-designed as a three-part online event.

In transitioning to an online workshop, the RISRS team conducted a landscape scan to understand available platforms, emerging strategies, and potential problems in conducting expert meetings online. Additionally, we consulted with the RISRS advisory board about the feasibility of taking the workshop online. This supported an intensive discussion of scheduling and feedback on how to strategize to overcome divergent timezones, professional schedules and time commitments, and technological limitations. Many of the stakeholders, particularly those coming from government or corporations, faced limitations on which technology platforms they were allowed to use. Similarly, the issue of scheduling proved difficult. Aligning professional schedules across multiple timezones took several rounds of surveys of the advisory board to narrow down to an acceptable time commitment.

Workshop Facilitation

The design of in-person workshop proposed use of conversational design patterns known as Liberating Structures (Lipmanowicz & McCandless, 2014)(http://www.liberatingstructures.com). The strength of these patterns is that they allow for distributed control over how topics in meetings are shaped, allowing for the introduction of novel changes to standardized agenda items. Many of the patterns include guided instructions for how groups work together in-person

for collaborative problem solving and decision making. To translate these strengths into a virtual format, the RISRS team attended multiple online trainings in virtual facilitation.

Ultimately, Liberating Structures shaped our virtual facilitation environment: we aimed for a participatory format that maintained the original intent, using platforms and tools that we could use during the workshop, such as breakout rooms, 'do-athon' formats, and structured plenary sessions. During the first workshop, for example, the opening plenary was organized into a cross-sectoral fishbowl-style discussion organized by professional and industry groupings. By contrast, for the second activity of that day participants were organized around topics of interest derived from preliminary research materials. On subsequent workshop days, participants were organized into working and discussion groups by the RISRS team based on surveys of their preferences, and a selection of topics nominated by workshop participants. This interactive structure allowed stakeholders to offer a diversity of perspectives on a broad number of problems.

Each session utilized a series of collaborative documents designed around conversational scaffolding, providing a focus for problem solving and a series of artifacts that aided in harvesting stakeholder ideas, opinions, and objections. Additionally, members of the RISRS team were embedded in all of the workshop events as notetakers and participant observers, where their notes provided context and detail the construction of these artifacts. These documents, suggestions, and reports, were analyzed by the RISRS team, and the results of the analysis—salient recommendations and themes—were subsequently presented to the stakeholders for refinement, comment or adaptation. Additionally, the RISRS team organized a series of surveys scheduled between workshop meetings to encourage robust feedback on the evolving draft recommendations.

Stakeholder Synthesis

One advantage of taking the workshop online was that the extended design, with time between workshops, allowed the RISRS team to spend time with the materials produced by stakeholders, and to develop and nuance the organization of the workshop in ways that served to benefit stakeholder collaboration.

As each workshop evolved, participants offered iterative and ongoing feedback, nominating additional areas of interest and functional interest groups that mixed and matched participants over the course of the three workshop sessions. Workshop sessions were organized around a series of synchronous activities that facilitated stakeholder feedback and engagement during the live virtual events. Prior to and between each workshop, the RISRS team combined themes from the interviews and literature reviews to select agenda items for stakeholder discussion. These themes and agenda items were elaborated with structured conversational prompts designed to support stakeholder interaction and cooperative problem-solving. Using these materials, stakeholders discussed common issues, outlined common challenges and unique impediments to action, possible areas of accountability and pathways for implementing actionable change in the future.

The stakeholder consultation process, and stakeholders' collaborative role in the ongoing project synthesis, help to create a rich, nuanced portrait of the role of retraction in the scientific ecosystem. This portrait is reflected in both the scope of the recommendations and their grounding in actionable industry or sector level concerns. In addition to nuanced conversations about sector-specific retraction issues, this portrait included a number of overlapping leverage points to address the issue of retracted research and its continued citation from multiple complementary angles.

Stakeholder Feedback

After the second meeting, participants were sent a survey that asked them to evaluate and rank top-level suggestions that had re-occurred throughout the first two meetings. Based on these results, the team generated recommendations for discussion. At meeting three, participants reviewed this "zeroth draft" and refined them into a set of base recommendations, and potential avenues for implementation.

This iterative and ongoing feedback process helped to scope recommendations from broad concerns, to clear possibilities for action. After the workshop, we anticipate a second round of stakeholder consultations to bridge to perspectives that emerged as part of this extended stakeholder consultation, feedback and synthesis dynamic. As further stakeholders are added to the consultation process, their insights will be incorporated into the draft recommendations, and they will be given the opportunity to participate in the stakeholder feedback schedule.

As drafts of the white paper undergo further comment and feedback, these recommendations will be developed into a final body of recommendations, as well as a research agenda and implementation model. Additional viability testing on proposed implementation strategies will undergo an additional feedback and synthesis process involving a smaller body of stakeholder volunteers asked to focus on evaluating the link between recommendations and proposed implementation actions.

Interview Questions

A. BIOGRAPHY, PROFESSIONAL LIFE AND ROLE

Q.1. What has been your experience with retracted papers?

Q.2. In your current position have you worked with or encountered papers or articles with a retracted status? Can you describe how you worked with that situation?

B. PROBLEM DEFINITION AND UNDERSTANDING

Q.3. Please describe the issues involved with retracted papers. How would you characterize the issues?

Q.3.a. In your opinion, what problems do they pose for scientific publishing?

Q.4. How would you describe the different varieties—types or classes—of retracted papers?

    Q.4.a. Are there any of these varieties that can be cited?

    Q.4.b What are the conditions for this type of citation?

Q.5. How do you characterize the harm associated with retracted research?

C. PUBLISHING ECOSYSTEM

Q.6. Thinking about the publishing industry, how would you describe the process of managing or mitigating the effects of retracted papers?

Q.7. Thinking of this process, who would you say is involved in the process of managing or mitigating the effects of retracted papers?
    Q.7.a. What is their role or position?

Q.8. Based on your experience, how would you suggest stopping the spread of retracted papers?

Q.9. Have you had any success collaborating with your colleagues and professional peers to address the spread of retracted papers?

Q.10. In your opinion, would you say there are any special problems associated with Open Access and retracted papers?

    Q.10.a Do you see any impediments to retraction statuses and retraction notices for Open Access Publishing?

Q.11. Similarly, in your opinion, would you say there are special problems associated with selfcitation and retracted papers?

    Q.11.a. Do you see any impediments to the use of retraction statuses and retraction notices involving self-citation and retracted papers.

Workshop Invitation

Dr. Jodi Schneider
School of Information Sciences
University of Illinois at Urbana-Champaign 501 E. Daniel St
Champaign, IL 61820

[***Insert name &address***]

Dear [***name***], I am pleased to invite you to participate in a virtual workshop entitled "Reducing the Inadvertent Spread of Retracted Science: Shaping a Research and Implementation Agenda." Funded by the Alfred P. Sloan Foundation, this event will bring together a diverse group of stakeholders in the scientific publishing ecosystem to launch a collaborative effort to reduce the citation and reuse of retracted publications.

I am particularly interested in benefiting from your perspective as [***position***] and believe you are well positioned to represent the important perspectives of the [***field/industry***] in the discussion, as well as to communicate the perspectives of other stakeholders back to your peers. The goal of this project is to distill a coherent, actionable set of recommendations for next steps which will be disseminated to a broader community in a white paper and at conferences.

The workshop will be held remotely as a series of structured discussions. During this time, we will have the opportunity to consider the important issue of reducing the continued citation of retracted papers.

In addition to the workshop, your participation may also include:

- A one-hour interview with the project team this spring
- Submission of a 2-4-page discussion paper on this topic by [***date***].
- Voluntary conversation on discussion papers (identifying problems, suggesting possible reforms, etc.) with other participants prior to the workshop.

To help shape the broader conversation on retracted science, if you choose to participate in the workshop your participation in the workshop, along with your contribution of a discussion paper, and the major outcomes from our work together will be shared on a project website.

If you cannot attend the workshop, please let us know if you would participate in the study interview. Any insights you might share with us would be of value.

We would appreciate your response to this invitation no later than [***date***]. The success of the workshop depends on the expertise and engagement of the stakeholder communities. I would be honored to have you at the table.

Sincerely,
Jodi Schneider (PI)
Assistant Professor
School of Information Sciences
University of Illinois at Urbana-Champaign

Reducing the Inadvertent Spread of Retracted Science:
Shaping a Research and Implementation Agenda

Retracted Science

ALFRED P. SLOAN
FOUNDATION

Monday Oct 26th

DAY 1 Listening and Learning

Welcome and Introductions
6:00-6:20 AM (PT) | 7:00-7:20 AM (MT) | 8:00-8:20 AM (CT) | 9:00-9:20 AM (ET) | 1:00-1:20 PM (UK) | 2:00-2:20 PM (CEST)

Stakeholder Experience Fishbowl Storytelling (20 min per group)

Structure: 5 min round robin, 10 min discussion, 5 min Q&A from audience
Based on your experience or expertise, what do you want others to know about retractions? What problems are associated with retraction in your community? Can these problems be solved? How?

GROUP 1 - NORMS, STANDARDS, AND INCENTIVES
6:20-6:40 AM (PT) | 7:20-7:40 AM (MT) | 8:20-8:40 AM (CT) | 9:20-9:40 AM (ET) | 1:20-1:40 PM (UK) | 2:20-2:40 PM (CEST)

People working in standards organizations, funding agencies, or journalism, or in investigating reform in standards and incentives.

- Monya Baker, Senior Editor, Comment Desk, Nature magazine
- Daniele Fanelli, Fellow in Quantitative Methodology, Department of Methodology, London School of Economics and Political Science
- Ashley Farley, Program Officer, Knowledge & Research Services, Bill & Melinda Gates Foundation
- Josh Greenberg, Program Director, Alfred P. Sloan Foundation
- Alice Meadows, Director of Community Engagement, NISO
- Ivan Oransky, Co-Founder of Retraction Watch & Vice President, Editorial at Medscape, Distinguished Writer In Residence at New York University's Carter Journalism Institute, and president of the Association of Health Care Journalists
- Deborah Poff, Chair of the Trustee Board COPE & Editor in Chief Journal of Academic Ethics
- Eefke Smit, Director of Standards and Technology, International Association of STM Publishers

GROUP 2 - PUBLISHING INDUSTRY
6:45-7:05 AM (PT) | 7:45-8:05 AM (MT) | 8:45-9:05 AM (CT) | 9:45-10:05 AM (ET) | 1:45-2:05 PM (UK) | 2:45-3:05 PM (CEST)

People in the publishing industry, e.g. editors, publishers, peer review, managers, quality assurance staff.

- IJsbrand Jan Aalbersberg, Chair of the Standards and Technology Executive Committee of STM; SVP Research Integrity, Elsevier
- Michele Avissar-Whiting, Editor in Chief for Research Square (tentative)
- Annette Flanagin, Executive Managing Editor and Vice President, Editorial Operations, JAMA and The JAMA Network, and Executive Editor, JAMAevidence
- Dan Kulp, Director, Editorial Development for the journals of the American Chemical Society
- Michael Markie, Publishing Director, Life Sciences, F1000
- Katrina Pickersgill, Executive Peer Review Manager, SAGE Publications, Ltd.
- Sarah Robbie, Head of Research Integrity & Ethics, Taylor and Francis
- Randy Townsend, Director, Journal Operations at American Geophysical Union

GROUP 3 - BRIDGING TECHNOLOGY

7:10-7:30 AM (PT) | 8:10-8:30 AM (MT) | 9:10-9:30 AM (CT) | 10:10-10:30 AM (ET) | 2:10-2:30 PM (UK) | 3:10-3:30 PM (CEST)

People whose work supports interlinking and interconnection of scholarly publishing items, e.g. citation verification software, reference management systems, and bibliographic databases (indexing and abstracting, citations) and underlying technologies such as identifiers and metadata.

- Geoff Bilder, Director of Technology and Research, Crossref
- Helena Cousijn, Community Engagement Director, DataCite
- Nicholas DeVito, Doctoral Researcher, EBM DataLab, University of Oxford
- James Leung, Head of Product Management, Kopernio, Clarivate
- Josh Nicholson, Co-founder and CEO scite
- Laura Paglione, Project Lead, Metadata2020
- John Seguin, President and Chief Librarian, Third Iron LLC
- Sean Takats, Director of Zotero & Professor/Chief Scientist University of Luxembourg

BREAK - 15 MINUTES
7:30-7:45 AM (PT) | 8:30-8:45 AM (MT) | 9:30-9:45 AM (CT) | 10:30-10:45 AM (ET) | 2:30-2:45 PM (UK) | 3:30-3:45 PM (CEST)

GROUP 4 - RESEARCH INTEGRITY
7:45-8:05 AM (PT) | 8:45-9:05 AM (MT) | 9:45-10:05 AM (CT) | 10:45-11:05 AM (ET) | 2:45-3:05 PM (UK) | 3:45-4:05 PM (CEST)

People in a research integrity office in government or a university, supporting research integrity efforts/investigations in publishing.

- Elisabeth Bik, Science Integrity consultant & Microbiome
- Stephanie Boughton, Cochrane Research Integrity Editor
- Francesca Grifo, Scientific Integrity Official Environmental Protection Agency
- CK Gunsalus, Director, National Center for Professional & Research Ethics, Professor Emerita of Business, and Research Professor at the Coordinated Sciences Laboratory, University of Illinois at Urbana-Champaign
- Christopher Lehmann, Research Integrity Officer, University of Illinois, Urbana-Champaign

GROUP 5 - RESEARCHERS & LIBRARIANS

8:10-8:30 AM (PT) | 9:10-9:30 AM (MT) | 10:10-10:30 AM (CT) | 11:10-11:30 AM (ET) | 3:10-3:30 PM (UK) | 4:10-4:30 PM (CEST)

People producing and/or facilitating access to original research.

- Caitlin Bakker, Medical School Librarian and Research Services Coordinator, Health Sciences Library University of Minnesota
- Jennifer Deal, Librarian Lead and Institutional Repository Manager, Advocate Aurora Library
- Karen Hanus, Director, Advocate Aurora Library, St. Luke's Medical Center
- Tom Heyman, Assistant Professor, Methodology & Statistics, Faculty of Social Sciences, Leiden University
- Kathryn Kaiser, Assistant Professor, Dept. of Health Behavior, University of Alabama Birmingham
- Kathrin McConnell, Director, FDA Library, Office of Information Management and Technology
- Pamela Ronald, Distinguished Professor, Department of Plant Pathology, College of Agricultural and Environmental Sciences, University of California, Davis
- Barbara Ruggeri, Life & Health Sciences Librarian, Carroll University
- Elizabeth Suelzer, User Education and Reference Librarian Medical College of Wisconsin
- Nicole Theis-Mahon, Liaison Librarian & Health Sciences Collection Coordinator, Health Sciences Library University of Minnesota

BREAK - 15 MINUTES
8:30-8:45 AM (PT) | 9:30-9:45 AM (MT) | 10:30-10:45 AM (CT) | 11:30-11:45 AM (ET) | 3:30-3:45 PM (UK) | 4:30-4:45 PM (CEST)

Conversation Café - Thematic Discussions in breakout rooms - 45 min + 5 min notetaking
8:50 AM-9:45 (PT) | 9:50-10:45 AM (MT) | 10:50-11:45 AM (CT) | 11:50 AM-12:45 PM (ET) | 3:50-4:45 PM (UK) | 4:50-5:45 PM (CEST)

Group discussion in 4 rounds:

- First round: Each person shares thoughts about the topic. 5 min
- Second round: Each person shares thoughts after having listened to everybody in the room. 5 min
- Third round: open discussion 25 min
- Fourth round: each member shares takeaways, ideas, and thoughts for next steps. 10 min.

Group members record takeaways, thoughts, and ideas in shared Google Slides. 5 min.

Participants will self-select a breakout room. See discussion prompts table below.

- Types of retractions
- Informative retraction notices
- Communication of misconduct investigations
- Visibility of retraction status
- Author-initiated retraction
- *Rooms 6 - 10: Participant nominated topics TBD*

REPORT OUT FROM THEMATIC DISCUSSIONS / GATHERING EMERGING TOPICS FOR DAY 2 / WRAP-UP
9:45-10 AM (PT) | 10:45-11 AM (MT) | 11:45 AM-noon(CT) | 12:45-1:00 PM (ET) | 4:45-5:00 PM (UK) | 5:45-6:00 PM (CEST)

TABLE: DISCUSSION PROMPTS FOR CONVERSATION CAFE (Please suggest additional topics!)

Room	Prompt
Types of retractions	What would a common taxonomy for retractions include? What are industry requirements to make it feasible to apply?
Informative retraction notices	What are the obstacles to including detailed retraction information in retraction notices such as who is retracting and what is the reason for the retractions?
Communication of misconduct investigations	What do publishers need or expect from institutions conducting misconduct investigations? What are the disincentives for institutions to collaborate with publishers on issues of retraction?
Visibility of retraction status	What are the obstacles to consistent, clear identification of retraction status on publisher websites?

Author-initiated retraction	What options are there for author-initiated retraction? What challenges are there to author-initiated retractions?
Funding	What are impacts on funding and funders?
Timeliness in retractions	What are the primary obstacles to resolving retractions? Are their ways to speed up or improve the process?
Action today	Things we can do today to limit the spread of retracted science.
Timeliness of retractions	
Room 10	(please suggest a topic here)

Monday November 9th

DAY 2 Collaborative Agenda Setting

Welcome and Review of Agenda & Logistics (Plenary, 20 min)

6:00-6:20 AM (PT) | 7:00-7:20 AM (MT) | 8:00-8:20 AM (CT) | 9:00-9:20 AM (ET) | 2:00-2:20 PM (UK) | 3:00-3:20 PM (CET)

Implementation Solutions (Breakout group discussions, 30 min)

6:20-6:50AM (PT) | 7:20-7:50 AM (MT) | 8:20-8:50 AM (CT) | 9:20-9:50 AM (ET) | 2:20-2:50 PM (UK) | 3:20-3:50 PM (CET)

STRUCTURE: Each group will have a Google Doc to guide the discussion as follows:

1. List the implementation steps (15 min)
2. Determine who needs to be included (5-7 min)
3. Consider the impediments (5-7 min)

TOPICS/GROUPS:

A. **Adoption of COPE guidelines:** How do we facilitate further adoption of COPE guidelines as an industry-wide standard?
    a. Google Doc Day 2 - A - Adoption of COPE Guidelines
    b. Group
        i. Yoss Arianlou, University of Illinois Urbana-Champaign
        ii. Joerg Heber, Editorial Director PLOS and Editor-in-Chief PLOSOne
        iii. Hannah Heckner, Product Strategist, Silverchair
        iv. Stacey Lavelle, Senior Business Analyst, Aries Systems Corporation
        v. Deborah Poff, Editor in Chief Journal of Academic Ethics, Chair Trustee Board COPE
        vi. Sarah Robbie, Head of Research Integrity & Ethics, Taylor and Francis
        vii. Randy Townsend, Director, Journal Operations at American Geophysical Union

B. **Use of Retracted Science in Policy, Applied Science and Evidence-Based Practice:** What actions need to be taken when a retracted item has been used in a regulation, guideline, or systematic review?
    a. Google Doc Day 2 - B - Use of Retracted Science in Policy, Applied Science, and Evidence-Based Practice
    b. Group
        i. Stephanie Boughton, Research Integrity Editor, Cochrane
        ii. Stephen Gonsalves, Division of Education and Integrity, US Office of Research Integrity
        iii. Francesca Grifo, Scientific Integrity Official, Environmental Protection Agency
        iv. Kathryn Kaiser, Assistant Professor Dept of Health Behavior, University of Alabama Birmingham
        v. Kathrin Mc Connell, Director, FDA Library, Office of Information Management and Technology
        vi. Dmitry Malkov, University of Sussex
        vii. Jodi Schneider, University of Illinois Urbana-Champaign

C. **Robust Dissemination of Retraction Status:** How do we assure robust dissemination of retraction status information? What are the opportunities for sharing information across different scholarly publishing services? What is needed to ensure sustainability and data quality of retraction status information?
    a. Google Doc Day 2 - C - Robust Dissemination of Retraction Status
    b. Group
        i. Ashley Farley, Program Officer, Knowledge & Research Services, Bill & Melinda Gates Foundation
        ii. Patricia Feeney, Head of Metadata, Crossref
        iii. Katie Funk, Program Manager, PubMed Central
        iv. James Leung, Product Director, Clarivate Analytics
        v. Ivan Oransky, Co-Founder of Retraction Watch

D. Retraction Education for Researchers, Editors, and the Public: What does every researcher need to know about retraction? What does every editor need to know? What does the public need to know? Where does this happen and how?

E. End User Tools & Services: How do we get retractions and other post-publication updates into the workflow of end users?

F. Standards Development Process: What standards development process will help stakeholders agree on the problems posed and then reach consensus on approaches and potential solutions?

      iii.   Dan Kulp, Director, Editorial Development for the journals of the American Chemical Society

      iv.   Christopher Lehmann, Research Integrity Officer, University of Illinois, Urbana-Champaign

      v.   Alice Meadows, Director of Community Engagement, NISO

      vi.   Nathan Woods, University of Illinois at Urbana-Champaign

G. **Taxonomy Requirements:** In order to implement a taxonomy (of retraction or of post-publication updates) what needs to be true of the taxonomy? What is needed for its successful adoption across scientific publishing?

    a. Google Doc Day 2 - G - Taxonomy Requirements

    b. Group

      i.   Geoff Bilder, Director of Technology and Research, Crossref

      ii.   Nicholas DeVito, Doctoral Researcher, EBM DataLab, University of Oxford

      iii.   Annette Flanagin, Executive Managing Editor and Vice President, Editorial Operations, JAMA and The JAMA Network, and Executive Editor, JAMAevidence

      iv.   David Gillikin, Chief, Bibliographic Services Division, National Library of Medicine

      v.   Eefke Smit, Director of Standards and Technology, International Association of STM Publishers

BREAK - 15 MINUTES
6:50-7:05 AM (PT) | 7:50-8:05 AM (MT) | 8:50-9:05 AM (CT) | 9:50-10:05 AM (ET) | 2:50-3:05 PM (UK) | 3:50-4:05 PM (CET)

Min Specs (Continue in same breakout groups, 30 min)

7:05-7:35 AM (PT) | 8:05-8:35 AM (MT) | 9:05-9:35 AM (CT) | 10:05-10:35 AM (ET) | 3:05-3:35 PM (UK) | 4:05-4:35 PM (CET)

In the same groups from Part I, using the same Google Doc:

1. Quickly generate a list of all the must-dos and must-not-do's that should be considered to achieve a successful outcome to the proposed actions in the first session. (5-10 min)
2. Reduce the list to the absolute minimum by dropping anything that is not absolutely essential. Ask "If we violated this spec, could we still achieve our purpose?" If the answer is "yes" - drop it. (20 min)

BREAK - 15 MINUTES

7:35-7:50 AM (PT) | 8:35-8:50 AM (MT) | 9:35-9:50 AM (CT) | 10:35-10:50 AM (ET) | 3:35-3:50 PM (UK) | 4:35-4:50 PM (CET)

What? So What? Now What? Debrief (Plenary, 40 min)

7:50-8:30 AM (PT) | 8:50-9:30 AM (MT) | 9:50-10:30 AM (CT) | 10:50-11:30 AM (ET) | 3:50-4:30 PM (UK) | 4:50-5:30 PM (CET)

1. What? What happened in the small group discussions? What did you notice, what stood out?

2. So What? Why is this important? Where is there consensus? What solutions have enough support to be feasible?

3. Now What? What actions make sense? What solutions should we as a group consider? What are the next steps?

BREAK - 15 MINUTES

8:30-8:45 AM (PT) | 9:30-9:45 AM (MT) | 10:30-10:45 AM (CT) | 11:30-11:45 AM (ET) | 4:30-4:45 PM (UK) | 5:30-5:45 PM (CET)

15% Solution (Individual brainstorming & small breakout group discussions, 45 min)

8:45-9:30 AM (PT) | 9:45-10:30 AM (MT) | 10:45-11:30 AM (CT) | 11:45 AM-12:30 PM (ET) | 4:45-5:30 PM (UK) | 5:45-6:30 PM (CET)

STRUCTURE: "What is your 15 percent? Where do you have discretion and freedom to act? What can you do without more resources or authority?"

1. 5 minutes alone to generate your own list
2. Individuals share their ideas with the small group one at a time (3 min each)
3. Group members provide a consultation to one another - asking clarifying questions and offering advice (5-7 min per person)

4. Share in Google Doc: Day 2 15% Solution Ideas or email MT Campbell <mtc@illinois.edu>

GROUPS:

1. **(moved)**
2. **Ashley Farley**, Bill & Melinda Gates Foundation; **Elizabeth Suelzer**, Medical College of Wisconsin; **Christopher Lehmann**, University of Illinois, Urbana-Champaign; **Stephanie Boughton**, Cochrane; **Katie Funk**, PubMed Central.
3. **Annette Flanagin**, JAMA and The JAMA Network; **Josh Greenberg** (part of this time), Alfred P. Sloan Foundation; **Joerg Heber,** PLOS and PLOSOne; **Eefke Smit**, International Association of STM Publishers.
4. **Dan Kulp**, American Chemical Society; **Alice Meadows** (part of this time), NISO; **Ivan Oransky**, Retraction Watch; **Sarah Robbie**, Taylor and Francis.
5. **IJsbrand Jan Aalbersberg**, Elsevier; **Elisabeth Bik**, Microbiome and Science Integrity consultant; **Deborah Poff**, COPE; **Randy Townsend**, American Geophysical Union.
6. **(moved)**
7. **David Gillikin**, National Library of Medicine; **Francesca Grifo**, Environmental Protection Agency; **Kathrin McConnell**, FDA Library; **Capt Stephen Gonsalves**, US Office of Research Integrity.
8. **Caitlin Bakker**, Health Sciences Library Univ of Minnesota; **Kathryn Kaiser**, University of Alabama Birmingham; **David Moher**, Ottawa Hospital Research Institute; **Nicholas DeVito**, University of Oxford.
9. **(moved)**
10. **Michele Avissar-Whiting**, Research Square; **Geoff Bilder**, Crossref; **James Leung**, Clarivate Analytics; **Jodi Schneider**, University of Illinois at Urbana-Champaign; **John Seguin**, Third Iron LLC.
11. **Daniele Fanelli**, London School of Economics and Political Science; **Nicole Theis-Mahon**, University of Minnesota; **Dmitry Malkov**, Sussex University.
12. **Patricia Feeney**, Crossref; **Stacey Lavelle**, Aries Systems Corporation; **Josh Nicholson**, scite.
13. **Elsa Alvaro**, Northwestern University Libraries; **Joanne Berger**, FDA Library; **Karen Hanus**, Advocate Aurora Library; **Barbara Ruggeri**, Carroll University.

Wrap up and looking ahead to Day 3 (Plenary, 20 min)

9:40-10:00AM (PT) | 10:40-11:00 AM (MT) | 11:40 AM-12:00 PM (CT) | 12:40-1:00 PM (ET) | 5:40-6:00 PM (UK) | 6:40-7:00 PM (CET)

Monday November 16th

DAY 3 Commitment to Action

Welcome and Review of Agenda & Logistics (Plenary, 15 min)

6:00-6:15 AM (PT) | 7:00-7:15 AM (MT) | 8:00-8:15 AM (CT) | 9:00-9:15 AM (ET) | 2:00-2:15 PM (UK) | 3:00-3:15 PM (CET)

Planning for collaboration and action (Breakout groups, 45 min)

6:15-7:00AM (PT) | 7:15-8:00 AM (MT) | 8:15-9:00 AM (CT) | 9:15-10:00 AM (ET) | 2:15-3:00 PM (UK) | 3:15-4:00 PM (CET)

STRUCTURE: Groups will be determined by survey responses Day 3 Agenda Setting; please answer the survey if you haven't.

Each group will have a Google Doc to guide the discussion as follows:

How do we move the implementation of this recommendation forward?

1. Who needs to collaborate and what is their role? (10 min)
2. What resources are needed? (10 min)
3. What collaborative action can we take to make progress? (15 min)
4. Do we need more information or participation from other participants?

GROUPS:

A. Support resources and standards to create open, sustainable non-proprietary databases with APIs to track and disseminate retraction statuses.
    a. Google Doc Day 3 - A - Database
    b. Group
        i. Elsa Alvaro, Director of Academic Engagement, Librarian for Chemistry, and Chemical and Biological Engineering, Northwestern University Libraries
        ii. Geoff Bilder, Director of Technology and Research, Crossref
        iii. Halle Burns, Data Librarian & Instructor, University of Nevada Las Vegas
        iv. Ashley Farley, Program Officer, Knowledge & Research Services, Bill & Melinda Gates Foundation
        v. James Leung, Product Director, Clarivate
        vi. Kathie McConnell, Director, FDA Library, Office of Information Management and Technology
        vii. Ivan Oransky, Co-Founder of Retraction Watch & Editor in Chief, Spectrum, Distinguished Writer In Residence at New York University's Carter Journalism Institute, and president of the Association of Health Care Journalists
        viii. John Seguin, President & Chief Librarian, Third Iron LLC
        ix. Sean Takats, Professor/Chief Scientist, University of Luxembourg; Director of Zotero

B. Recommend retraction metadata statuses that can be adopted by all stakeholders.
    a. Google Doc Day 3 - B - Retraction Metadata
    b. Group
        i. Elisabeth Bik, Microbiome and Science Integrity consultant
        ii. Helena Cousijn, Community Engagement Director, DataCite
        iii. Jennifer Deal, Librarian Lead and Institutional Repository Manager, Advocate Aurora Library
        iv. Stephen Gonsalves, Division of Education and Integrity, US Office of Research Integrity
        v. Randi Proescholdt, University of Illinois, Urbana-Champaign

C. Recommend a taxonomy of retraction statuses that can be adopted by all stakeholders.
    a. Google Doc Day 3 - C - Retraction Taxonomy
    b. Group
        i. Yoss Arianlou, University of Illinois, Urbana-Champaign
        ii. Patricia Feeney, Head of Metadata, Crossref
        iii. Annette Flanagin, Executive Managing Editor and Vice President, Editorial Operations, JAMA and The JAMA Network, and Executive Editor, JAMAevidence
        iv. Katie Funk, Program Manager, PubMed Central

     v.   Karen Hanus, Director, Advocate Aurora Library
    vi.   Joerg Heber, Editorial Director PLOS and Editor-in-Chief PLOS ONE
   vii.   Stacey Lavelle, Senior Business Analyst, Aries Systems Corporation
  viii.   Dmitry Malkov, master's student, Science Policy Research Unit, University of Sussex
    ix.   Deborah Poff, Editor-in-Chief, Journal of Academic Ethics; Chair, Trustee Board COPE
    x.   Eefke Smit, Director of Standards and Technology, International Association of STM Publishers

D. Responsible Conduct of Research (RCR) Education.
    a. Google Doc Day 3 - D - RCR Education
    b. Group
       i.   Michele Avissar-Whiting, Editor-in-Chief, Research Square
      ii.   Joanne Berger, Lead Librarian, U.S. Food and Drug Administration
     iii.   Nicholas De Vito, Doctoral Researcher, EBM DataLab, University of Oxford
     iv.   Tzu-Kun (Esther) Hsiao, University of Illinois, Urbana-Champaign
      v.   Kathryn Kaiser, Assistant Professor, Dept of Health Behavior, University of Alabama Birmingham
     vi.   Barbara Ruggeri, Life and Health Sciences Librarian, Carroll University

E. Strategy & ownership for standards and best practice development.
    a. Google Doc Day 3 - E - Standards Development
    b. Group
       i.   Tom Heyman, Assistant Professor, Social and Behavioural Sciences, Leiden University
      ii.   Daniel Kulp, Director, Editorial Development for the journals of the American Chemical Society & COPE Vice-Chair
     iii.   Christopher Lehmann, Research Integrity Officer, University of Illinois, Urbana-Champaign
     iv.   Alice Meadows, Director of Community Engagement, NISO
      v.   Katrina Pickersgill, Executive Peer Review Manager, SAGE Publications, Ltd. (?)
     vi.   Bruce Rosenblum, Vice President of Content & Workflow Solutions, Inera Inc
    vii.   Nathan Woods, University of Illinois, Urbana-Champaign

F. Streamlining the retraction process.
    a. Google Doc Day 3 - F - Streamlining the retraction process
    b. Group
       i.   IJsbrand Jan Aalbersberg, Chair of the Standards and Technology Executive Committee of STM; SVP Research Integrity, Elsevier
      ii.   Yuanxi Fu, University of Illinois, Urbana-Champaign

          iii.   Sarah Robbie, Head of Research Integrity and Ethics, Taylor and Francis
          iv.   Liz Suelzer, User Education and Reference Librarian, Medical College of Wisconsin

G. Public awareness about how retraction is a part of science
- a. Google Doc Day 3 - G - Public awareness about retraction
- b. Group
  - i. Monya Baker, Senior Editor, Comment Desk, Nature magazine (plenary)
  - ii. Daniele Fanelli, Fellow in Quantitative Methodology, Department of Methodology, London School of Economics and Political Science (part day)
  - iii. Josh Greenberg, Program Director, Alfred P. Sloan Foundation
  - iv. Francesca Grifo, Scientific Integrity Official, Environmental Protection Agency
  - v. Josh Nicholson, Co-founder and CEO scite
  - vi. Jodi Schneider, University of Illinois, Urbana-Champaign

NISO session:

          vii.   Caitlin Bakker, Medical School Librarian and Research Services Coordinator, Health Sciences Library, University of Minnesota
        viii.   Hannah Heckner, Product Strategist, Silverchair
          ix.   Randy Townsend, Director, Journal Operations at American Geophysical Union

BREAK - 15 MINUTES
7:00-7:15 AM (PT) | 8:00-8:15 AM (MT) | 9:00-9:15 AM (CT) | 10:00-10:15 AM (ET) |3:00-3:15 PM (UK) | 4:00-4:15 PM (CET)

A "Call to Action" Discussion & Recruiting Session (Plenary, 20 min)

7:15-7:35 AM (PT) | 8:15-8:35 AM (MT) | 9:15-9:35 AM (CT) | 10:15-10:35 AM (ET) | 3:15-3:35 PM (UK) | 4:15-4:45 PM (CET)

What collaborative action are you taking? Who do you need to recruit from the room?

Do-a-thon (Breakout groups, 30 min)

7:45-8:15AM (PT) | 8:45-9:15 AM (MT) | 9:45-10:15 AM (CT) | 10:45-11:15 AM (ET) | 3:45-4:15 PM (UK) | 4:45-5:15 PM (CET)

Continue breakout sessions, now task-focused, with possibly re-configured groups using the same Google Doc:

1. Task: Now that you have set a task, work in the same or reconfigured groups.
   Further develop your collaborative action.
   Even if you can't finish now, you can go home with a working draft.

GROUPS (same topics as above + any new topics that emerge):

A. A stand-alone, non-proprietary database to track and disseminate retraction status.
   a. Google Doc (same as above)
   b. Group
B. All stakeholders should adopt standard retraction metadata.
   a. Google Doc (same as above)
   b. Group
C. Develop a taxonomy of retraction statuses shared and adopted by all stakeholders.
   a. Google Doc (same as above)
   b. Group
D. Responsible Conduct of Research (RCR) Education
   a. Google Doc (same as above)
   b. Group
E. Strategy & Ownership for standards and best practice development
   a. Google Doc (same as above)
   b. Group
F. Streamlining the retraction process.
   a. Google Doc (same as above)
   b. Group
G. Public awareness about how retraction is a part of science

BREAK - 15 MINUTES
8:15-8:30 AM (PT) | 9:15-9:30 AM (MT) | 10:15-10:30 AM (CT) | 11:15-11:30 AM (ET) 4:15-4:30 PM (UK) | 5:15-5:30 PM (CET)

Dissemination Plans and White Paper Development (Plenary, 20 min)

8:30-8:50 AM (PT) | 9:30-9:50 AM (MT) | 10:30-10:50AM (CT) | 11:30-11:50 AM (ET) | 4:30-4:50M (UK) | 5:30-5:50 PM (CET)

Working Session (30 min)

9:00-9:30 AM (PT) | 10:00-10:30 AM (MT) | 11:00-11:30 AM (CT) | 12:00-12:30 PM (ET) | 5:00-5:30 PM (UK) |6:00-6:30 PM (CET)

Continue the do-a-thon. Or start a new collaborative task.

Final Wrap Up Plenary (15 min)

9:30-9:45M (PT) | 10:30-10:45 AM (MT) | 11:30--11:45 AM (CT) | 12:30-12:45 PM (ET) | 5:30-5:45 PM (UK) | 6:30-6:45 PM (CET)

Workshop Participant List

- IJsbrand Jan Aalbersberg, PhD, Chair of the Standards and Technology Executive Committee of STM; SVP Research Integrity, Elsevier

- Elsa Alvaro, PhD, Director of Academic Engagement, Librarian for Chemistry, and Chemical and Biological Engineering, Northwestern University Libraries

- Michele Avissar-Whiting, PhD, Editor-in-Chief, Research Square

- Monya Baker, Ed.M., Senior Editor, Comment Desk, Nature magazine

- Caitlin Bakker, MSLIS, Medical School Librarian and Research Services Coordinator, Health Sciences Library, University of Minnesota

- Joanne Berger, Lead Librarian, U.S. Food and Drug Administration

- Lisa Bero, PhD, Chief Scientist, Center for Bioethics and Humanities; Professor of Medicine and Public Health, University of Colorado Anschutz Medical Campus

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- CAPT Stephen Gonsalves, PhD, Division of Education and Integrity, US Office of Research Integrity

- Josh Greenberg, PhD, Program Director, Alfred P. Sloan Foundation

- Francesca Grifo, PhD, Scientific Integrity Official, Environmental Protection Agency

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- Kathryn Kaiser, PhD, Assistant Professor, Dept of Health Behavior, University of Alabama Birmingham

- Daniel T. Kulp, PhD, Director, Editorial Development for the journals of the American Chemical Society & COPE Vice-Chair

- Stacey Lavelle, Senior Business Analyst, Aries Systems Corporation

- Christopher Lehmann, PhD, Research Integrity Officer, University of Illinois, Urbana-Champaign

- James Leung, PhD, Product Director, Clarivate

- Dmitry Malkov, master's student, Science Policy Research Unit, University of Sussex

- Aaron Manka, PhD, Director, Research Integrity and Administrative Investigations, National Science Foundation - Office of Inspector General

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- David Moher, PhD, Director, Centre of Journalology, Ottawa Hospital Research Institute; Associate Professor, School of Epidemiology and Public Health, University of Ottawa

- Josh Nicholson, PhD, Co-founder and CEO scite

- Ivan Oransky, MD, Co-Founder of Retraction Watch & Editor in Chief of Spectrum, Distinguished Writer In Residence at New York University's Carter Journalism Institute,

BIBLIOGRAPHY

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