NISO RP-45-202x

Communication of Retractions, Removals, and Expressions of Concern (CREC)

A Recommended Practice of the
National Information Standards Organization

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DRAFT FOR PUBLIC COMMENT

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Foreword

About this Recommended Practice

In 2021, the NISO Voting Members approved a proposed work item focusing on the development of best practices for metadata transfer and display for retractions, removals, and expressions of concern.

The original statement of work articulated seven objectives to be addressed by the Working Group:

1) Recommended additions to existing metadata deliverables, as examples.
2) Proposed channels by which retraction information is distributed.
3) Suggested best practices around populating metadata in retraction notices, as well as in retracted publications and expressions of concern.
4) Identification of who is responsible for creation of metadata and what are the subsequent responsibilities of consumers of those metadata, e.g., display and indexing of retraction-related metadata.
5) Best practices around the communication of the item's status, including display labels, information available to support accessibility and machine processes, etc.
6) Recommendations regarding the visibility of the retracted digital object and consistency in signaling that status. Are there different solutions needed for different expressions of objects, e.g., will the requirements for a PDF version differ from those for an HTML, EPUB, or XML version?
7) An illustrative workflow process from issuing a retraction notice through display and discovery of the retracted item; implementation will be modeled and scalability will be considered.

NISO Topic Committee Members

The Information Discovery & Interchange Topic Committee had the following members at the time it approved this Recommended Practice:

[*to be added by NISO after approval*]

NISO CREC Working Group Members

The following individuals served on the NISO CREC Working Group, which developed and approved this Recommended Practice:

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Trademarks, Services Marks

Section 1: Introduction

1.1 Purpose and Scope

Publications may be retracted or removed, or expressions of concern (EoCs) may be issued, for a broad range of reasons, including error, misconduct, and fraud. While retractions are valuable mechanisms by which to correct the scientific and scholarly record, correcting the record requires that these decisions be clearly communicated and broadly understood. Unclear and inconsistent representation of the retracted status of published works may ultimately contribute to continued uncritical use of these invalidated publications in the scholarly literature.

The primary aim of this Recommended Practice is to establish best practices for metadata creation, transfer, and display for both the original publication and the statement of retraction, removal, or EoC, with the goal of facilitating the timely and efficient communication of information to all relevant stakeholders. Although retraction remains relatively rare, rates of retraction are increasing, and mass retractions have emerged. The need for best practices for metadata transfer and display has increased along with growth in retractions, removals (which are still rare and should be justified), and EoCs.[1] It is crucial that researchers who discover a publication be able to identify the status of the research reported. It is therefore necessary that the identification of retracted items, removed content, and EoCs be effectively communicated to human researchers and that these same features be evident to machine-reading and other automated processes, as well as to other interested parties in the scholarly information workflow.

Some organizations may have internally consistent practices for the transfer and display of metadata for retracted and removed publications, or for publications with associated EoCs, but such consistency is not universal. Moreover, differing practices across organizations or over time can pose challenges in creating commonly understood outputs. These practices may include using the same DOI for both a retraction notice and the retracted publication; removing the metadata record rather than updating it; and variable display across and within platforms and publication venues, such as journals and book series. While differing workflows are unavoidable, given the range of organizational structures managing the life cycle of scholarly publications, a lack of standards creates an inconsistent user experience that may result in the continued inappropriate use of problematic publications.

1.1.1 Scope

This Recommended Practice does not consider the rationale or decision-making processes associated with issuing an EoC, retracting a publication, or removing content, as guidance on these activities has been provided by organizations such as the Committee on Publication Ethics (COPE).[2] Instead, it focuses on the metadata and display elements that will help better communicate these decisions once they have been made.

The working group has defined metadata elements for the retracted publication, retraction notice, and EoC, including where elements can be used to describe related items, such as preprints, datasets, supplemental materials, and conference presentations. When these metadata elements are supplied by the publisher or other responsible body, it is expected that those involved in onward communication or

[1] Schneider, J., Woods, N.D., Proescholdt, R., & the RISRS Team. (2022). Reducing the inadvertent spread of retracted science: recommendations from the RISRS report. *Research Integrity and Peer Review* 7, 6. https://doi.org/10.1186/s41073-022-00125-x

[2] COPE Council. (2019). Retraction guidelines. https://doi.org/10.24318/cope.2019.1.4

dissemination will take appropriate actions as described to visibly communicate the status of the item where it is displayed, downloaded, or formatted for citation or email.

Other post-publication notices, such as errata, corrigenda, addenda, and corrections, as well as author name changes implemented without a linked correction notice, are not within the scope of this Recommended Practice. However, the recommendations for minimum metadata standards may be relevant for these other notices.

1.2 Terms and Definitions

These terms may be used differently in different publisher workflows (e.g., some publishers use the term *removal* when others would use *withdrawal*). Although establishing industry-wide terminology and definitions is out of scope, the terms are used in this document with the meanings indicated below:

Term	Definition
Retraction	A corrective action applying to an entire work which "is the result of a pervasive error, nonreproducible research, scientific misconduct, or duplicate publication."[3]
Retracted publication	The original publication upon which the corrective action of retraction is taken.
Retraction notice	Also referred to as a *statement of retraction* or *notice of retraction*. A distinct publication issued to announce the retraction of the original publication.
Retraction process	The procedure of undertaking the corrective actions to implement the retraction.
Removal	A corrective action applied to the entire publication in which the full text of the publication is made unavailable, but the metadata is preserved. Removal is rare and reserved for situations in which it may be necessary for the publication to be removed upon retraction (e.g., the removal of the publication is required by court order; the information in the publication may present a risk to personal privacy, a third party's legal rights, public or environmental health and well-being; or information in the article was published without the required licenses having been obtained).
Expression of concern (EoC)	A notice issued typically by an editor to draw attention to possible problems within a publication. It may but does not necessarily precede further editorial action on the publication.[4]

[3] Council of Scientific Editors. (2012). Section 3.5. Correcting the literature. In *Recommendations for Promoting Integrity in Scientific Journal Publications.* https://cse.memberclicks.net/3-5-correcting-the-literature

[4] COPE. https://publicationethics.org/forum-discussion-topic-comments-please-10

Accepted manuscript	The version of a journal publication that has been accepted for publication in a journal. A second party (the publisher) takes permanent responsibility for the publication. Content and layout follow the publisher's submission requirements.[5]
Version of record (VoR)	A fixed version of a journal publication that has been made available by any organization that acts as a publisher by formally and exclusively declaring the article published. This includes any early release publication that is formally identified as being published even before the compilation of a volume issue and assignment of associated metadata, as long as it is citable via some permanent identifier(s). It does not include any early release publication that has not yet been fixed by processes that are still to be applied, such as copy editing, proof corrections, layout, and typesetting.[5]

1.3 Interested Parties and Partners

The CREC Working Group aimed to include representation and involvement from a range of groups involved in retractions, removals, and expressions of concern. These groups included:

- **Publishers:** Academic publishers that produce and distribute works of academic research and scholarship through nonfiction books, journals, textbooks, and online resources.[6]
- **Aggregators:** Organizations that have developed a "bibliographic service that provides online access to the digital full text or indexed citations … published by different publishers"[7] (databases, full-text collections, discovery tools, etc.) or solutions that take care of "the aggregation, curation, and utilization of information about research,"[8] including research information management systems (RIMS), also known as current research information systems (CRIS).
- **Web vendors/full-text hosts:** "A vendor who is contracted by the publisher to host full text of publications in a single, searchable database, to which access is enabled by subscriptions to individual publications, or article document delivery, rather than a license to the entire database or parts thereof. A full-text host also differs from an aggregator in that it will usually be the publisher's 'primary' host."[7]

[5] NISO. (2008). NISO RP-8-2008, Journal article versions (JAV): Recommendations of the NISO/ALPSP JAV Technical Working Group. https://www.niso.org/publications/niso-rp-8-2008-jav

[6] Publishers Association. (n.d.). Learn about the industry. https://www.publishers.org.uk/about-publishing/learn-about-the-industry/

[7] NISO. (n.d.). KBART glossary of relevant terms. https://www.niso.org/standards-committees/kbart/kbart-glossary-relevant-terms

[8] Bryant, R., Clements, A., Feltes, C., Groenewegen, D., Huggard, S., Mercer, H., Missingham, R., Oxnam, M., Rauh, A., & Wright, J. (2017). Research information management: Defining RIM and the library's role. *OCLC Research.* https://doi.org/10.25333/C3NK88

- **Libraries:** Organizations that may be affiliated with educational institutions, research institutes, commercial organizations, or other groups, which acquire and facilitate access to content produced by publishers and made available through web vendors and aggregators.
- **Researchers and readers:** Individuals who may use and/or produce scholarly and scientific materials, including individuals engaged in meta-research and the study of research integrity.

Section 2: Summary of Recommendations

The following recommendations outline best practices for the creation, distribution, and display of standard metadata fields. The recommendations were developed with the understanding that publishers, aggregators and content providers have unique scholarly products, organizational procedures, and workflows that guide when and how retractions are issued, including various metadata-related practices. Given the range of technical and organizational structures and practices involved, as well as the complexity of the retraction process, a flexible approach to metadata practices was preferred. Rather than developing new metadata schemas, the Working Group instead focused on how existing, widely adopted metadata schemas could be leveraged to clearly and consistently transmit retraction-related metadata.

Section 3: provides guidance on mechanisms for distributing retraction-related metadata and outlines the publisher's responsibilities for metadata and associated actions, including actions such as watermarking PDFs, notifying aggregators and indexers, and notifying other parties as appropriate, including preprint servers and institutional or disciplinary repositories. Where feasible, the creation and distribution of retraction-related metadata should be part of standard editorial and production workflows. Guidance for platform vendors, aggregators, indexers, and others receiving and displaying retraction-related metadata is given in Section 4:, which describes best practices upon receipt of metadata for retracted items and retraction notices. Retraction-related metadata should be stored to facilitate communication between systems and parties, and be apparent to both human and machine readers, being present in both web and mobile interfaces and available through applicable APIs.

Section 5: defines retraction-related metadata elements. Metadata elements have been described as Essential, Essential if Available, and Recommended. These recommendations include 23 metadata elements for retracted publications (eight Essential, 14 Essential if Available, and one Recommended; see 5.1), and 20 metadata fields for retraction elements (eight Essential, two Essential if Available, and 10 Recommended; see 5.2). Essential and Essential if Available metadata elements represent the minimum information required to effectively identify the retracted publication, associate the retraction notice with the retracted publication, and ensure that the retracted status of a publication is clearly communicated to end users. Recommended elements serve two purposes: (1) to either expedite or streamline the identification and association workflow, as is the case with publisher ID, volume number, and issue number, or (2) to provide a fuller, more transparent representation of the retraction, as is the case with elements such as the cause or reason for retraction or the authors of the retraction notice.

These metadata elements can be integrated into established workflows and transmitted through existing channels. For specific information on using these metadata elements in JATS and Crossref, see Appendix A. The Working Group encourages publishers, aggregators, and content providers to include all Essential elements and as many Recommended elements as possible, to ensure the widest and most consistent dissemination of retraction related information. Additional implementation guidance is available in Section 6:.

Specific considerations for removals and expressions of concern (EoCs) are included (see 4.4 and 5.3), and other complex scenarios are expanded upon in Section 7:.

Section 3: Recommended Mechanisms for Distributing Information on Retracted Objects

To ensure the widest dissemination of information on retracted objects, we encourage publishers, aggregators, and other content providers to include the required metadata elements outlined in Section 5: and to provide as many of the optional elements as possible in all their standard metadata sets. The metadata should be embedded in the content itself, along with other metadata—for example, in HTML metatags and in PDF files where bibliographic and other metadata is being included.

Wherever possible, creating and populating these elements should become part of standard editorial and production workflows. It is the publisher's responsibility to ensure that the following actions are completed as part of the retraction process (for more detailed information on some of these steps, see Section 4::

- The metadata of the retracted publication has been modified to include "RETRACTED" in the article title.
- The PDF of the retracted publication has been watermarked to show that it has been retracted. In the case of publication removal, the PDF of the removed publication should contain the publication title, author list, and other relevant metadata such as date of publication, copyright, and data availability statements, but the abstract and the main body of the publication should be removed from the PDF. The truncated PDF of the removed publication should be watermarked to show that the work has been retracted.
- Any associated items have been corrected to note the publication's retraction. An associated item could include an alternative version, such as a preprint, or related works, such as articles that rely heavily upon the retracted publication (e.g., a meta-analysis that includes data from the retracted publication or commentary published alongside the original work).
- Any modifications to the retracted publication align with applicable accessibility standards (e.g., being keyboard-navigable or having elements that can be announced by a screen reader).
- The retraction notice contains all essential metadata elements noted in 5.1 (for retracted publications), 5.2 (for retraction notices) or 5.3 (for removed publications), along with as many recommended elements as possible.
- The retraction notice is freely available online when published.
- If the journal publishing the retraction uses issues, the retraction notice is published in an issue (online and, if applicable, in print).
- The retraction notice and retracted publication are clearly and bidirectionally linked on the publisher's web platform at publication.
- Reasonable efforts have been made to share the retraction notice with the author(s) of the retracted article prior to its publication.
- Aggregators and indexers that received the work originally are notified that the publication has been retracted.
- In the case of publication removals, reasonable efforts have been made to inform the data repositories that host data linked to the removed material.
- The publisher has considered whether notifying other relevant parties that the publication has been retracted is appropriate. These parties may include, but are not limited to:

- Preprint servers and institutional or disciplinary repositories, including those that may host the accepted manuscript
- Editors
- Editorial board members
- Reviewers
- Authors' institutions
- Authors' funding body or bodies
- Associated data repositories
- Third-party whistleblowers, complainants, or concerned readers

Ensuring that these actions are completed at the time when the retraction is published will help aggregators and indexers to update the retracted item and to create a relationship between the retracted publication and the retraction notice when they ingest the metadata.

A visual depiction of these recommendations is available in the Retraction Communication Flowchart in Appendix A. A table listing which parties should be responsible for, accountable for, consulted on, and informed of these actions is also available in Appendix A.

Content providers may also consider including the metadata elements within other alerting channels, such as e-ToCs and RSS feeds. Whatever channels are used, wider distribution of this (and other) article, chapter, or book metadata is likely to improve discovery and usage for the materials concerned.

Where possible, we recommend that retraction notices include the reason for the retraction, and, when applicable, notices of publication removal should include a statement that clarifies why the publication is being removed. In some cases, the reasons for retraction and removal may be the same, while in other cases there may be reasons to remove the publication in addition to the reasons for retracting it (e.g., an article may be retracted for dual publication and removed for breach of copyright licensing). The appropriate organizations should consider how best to incorporate the reason for retraction into existing formats, such as the Journal Article Tag Suite (JATS), ONline Information eXchange (ONIX), Resource Description Framework (RDF), and Dublin Core (DC).

While reasons are usually stated as free text, there may be benefits to using a taxonomy of reasons to more reliably communicate them in a machine-readable way. Some Working Group members use such a taxonomy, either internally or externally. Proposing a taxonomy of reasons that all stakeholders agree on is beyond the scope of this project, but we note that this work could be valuable in ensuring better communication of retractions in the future, provided that it is handled and curated carefully.

Note that there may be legal restrictions on what publishers are able to share; for example, institutional consent is required before sharing information on findings of misconduct in a public notice, and without this consent, the relevant tag cannot be added. Both people and machines may interpret the absence of certain tags as meaning that no such concerns are present, even though this is not necessarily true.

Section 4: Receipt, Display, and Transfer of Metadata

Publishers, platform vendors, aggregators, research information management systems (RIMS) providers, and indexers should strive to receive and thoughtfully store retraction metadata so that connected systems and services can act on and display this metadata to human and machine users. Here, we present recommendations for receiving, storing, and using retraction metadata.

4.1 Receipt and Storage

Retraction metadata should be stored in a way to facilitate consistent and prominent display, adhere to accessibility standards, and streamline metadata transfer, querying, and searchability in a future-proof way. Platform vendors and aggregators should consider what updates might be required to their metadata storage infrastructure and practices to ensure that the metadata is ready for use by all integrated systems, including their own. While the exact storage methods will vary across publishers and vendors, having a metadata storage and transfer strategy is essential to ensuring that the metadata is actionable in all integrated systems and displays.

4.2 Display

For the retraction process to be effective, it must be obvious to the user in the display on the user interface, in any download of the result or citation, and when saving the work. Although storage methods and systems will differ among publishers and vendors, entities that collect retraction metadata in accordance with the guidelines outlined in this document have the necessary resources to adhere to the remaining display recommendations.

Retraction metadata display functionality should be present for web and mobile interfaces based on the machine-readable metadata. Retraction metadata should also be identifiable when accessed through APIs. In alignment with COPE guidance, notices of retraction should always be openly available to the general public (i.e., not behind a paywall) on publishers' platforms.

When a publication is retracted, we recommend that the retracted status be indicated in the display by making, at a minimum, the following adjustments to the original publication:

1) Adding the word "RETRACTED" before the original main title of the publication, if not already present. This step makes the retracted status conspicuous, increasing the likelihood that users will consider it when deciding how to use the content in their research or teaching.
2) Prominently displaying a link to the retraction notice or EoC on the title or content page. A single work should be able to support multiple links; for example, if a publication had an EoC issued against it that resulted in the publication's retraction, links to both the EoC and retraction notice should be displayed.
3) Showing the DOI and all present metadata noted in this Recommended Practice, unless there are legal or ethical reasons not to do so.
4) Guaranteeing that the display of all metadata aligns with accessibility best practices, including being keyboard navigable and ensuring that a screen reader can announce all elements.

We also recommend that the publisher, aggregator, or platform vendor do the following:

1) Watermark the retracted publication's PDF with the word "RETRACTED" or replace the PDF with any updated PDF received from the publisher, following accessibility guidelines to ensure that the watermark can be read by users with visual impairment and can be announced by a screen reader. This step ensures that users who access PDFs directly through search results or their institution's archive can see the work's retracted status. If the publication is removed at the time

of retraction, ensure that the truncated PDF file of the removed publication is also watermarked with the word "RETRACTED."

2) Prominently differentiate retraction notice, retracted publication, and EoC metadata from other site elements to ensure that users recognize it. For example, placing information on the retracted status in a clearly signposted box on a content page, in a different color from other site elements, is more likely to catch users' attention.

3) Display related links and updates chronologically to tell the retracted publication's story over time. For example, if a publication has an EoC and is later retracted, the timeline for these events should be clearly indicated in the user interface.

4) Display metadata elements in a consistent order across websites and content pages to ensure a cohesive user experience and so that users can rely on finding similar data types in the same locations across a single platform. It may not be reasonable or immediately viable to update backfile content to match the desired display (e.g., due to inconsistencies in XML, because a platform vendor is not taking action on display, or because more technical resources are needed to ingest metadata appropriately to facilitate action). In these cases, we recommend that publishers and platform vendors take advantage of other backfile or website updates to add consistency to the display of retraction metadata.

4.3 Transfer

As applicable, publishers, platform vendors, and aggregators should communicate retractions, EoCs, and removals to integrated systems, partners, and indexing services to ensure they have the most recent, up-to-date information for their users. We recommend that systems used to make these transfers be designed or updated to make the transfers automatically when content is updated, if feasible and acceptable to the third party. If transfer systems cannot be configured to send updates automatically, we recommend creating a workflow to ensure that updates are sent in a timely manner, or on a regular cadence agreed with the third party.

4.4 Expressions of Concern

Expressions of concern (EoCs) are used to communicate concerns about publications. They are less common than retractions, relatively new as a notice type, and less well defined than retractions or corrections.[9] Publishers may therefore not have mature, established workflows for EoCs, and variation in how EoCs are implemented is greater than for other publication and retraction types. Some publishers use EoCs only as interim notices (i.e., EoCs will eventually be resolved with either a correction or a retraction), while others may also use EoCs as final editorial decisions on an article that will not be updated further. To ensure effective communication of EoCs, the same principles apply as for retractions.

4.4.1 Metadata

EoCs are publications in their own right, with all the metadata elements that exist in regular articles. This should include, at a minimum, the essential metadata required for retraction notices (see 5.1).

[9] Committee on Publication Ethics [COPE]. (2018). COPE Forum 26 February 2018: Expressions of concern. https://publicationethics.org/resources/forum-discussions/expressions-of-concern

When registering EoC metadata with Crossref, we recommend using the Crossmark mechanism[10] for linking the EoC and primary DOIs in the metadata, so that the EoC is visible through Crossmark and aggregators and other third-party services can derive EoC details from DOI information.

4.4.2 Management and Use

There are four main scenarios for an article with an EoC:

- A retraction notice is subsequently published.[11]
- A correction notice is subsequently published.[12]
- The EoC itself is found to be erroneous, incomplete, or no longer relevant.
- The issue(s) highlighted in the EoC cannot be resolved, but are not sufficient to warrant retraction according to COPE retraction guidelines and/or journal policies, so the EoC remains as a permanent notice.[13]

These scenarios are summarized in the EoC flowchart linked in Appendix A.

In all cases, the EoC should be treated as a component of the scholarly record, subject to the same standards of transparency and preservation.

Where an update to an EoC notice is necessary, whether updating the EoC notice itself or replacing it with a retraction or a withdrawal notice, any changes should be:

- Transparent
- Timestamped
- Compatible with onward communication to and actioning by third parties and aggregators
- Transferrable (e.g., when journals are transferred between publishers)

4.4.2.1 Special Considerations for EoCs

Unlike retracted publications, the PDFs of articles with an EoC are not generally watermarked. However, the same display principles as retracted publications otherwise apply.

EoCs should be:

- Prominent
- Consistent in display across a platform, including consistent use of terminology in notice title
- Freely available (not paywalled)
- Linked to the publication(s) to which they refer
- Accessible to both human and machine readers
- Transferrable (e.g., when journals move between publishers), including maintenance of linking to target publication(s)

The article(s) to which EoCs refer should:

[10] https://www.crossref.org/documentation/crossmark/participating-in-crossmark/

[11] E.g., https://doi.org/10.1371/journal.pone.0238679.

[12] E.g., https://doi.org/10.1371/journal.pone.0163216.

[13] E.g., https://doi.org/10.1371/journal.pone.0279457.

- Be linked to the EoC
- Clearly and accessibly indicate the changed status for both machine and human readers
- Have the Crossmark logo activated, where Crossmark is used

Examples of how these principles can be applied are outlined below:

- EoC flagged in publication header/top of publication landing page: https://doi.org/10.1371/journal.pone.0256488 or https://doi.org/10.1371/journal.pbio.3001631
- Title change of publication, including display in Google Scholar or similar: https://doi.org/10.1371/journal.pntd.0010924 or https://doi.org/10.1093/evolut/qpad094
- EoC associated with a set of articles: https://doi.org/10.1016/j.matpr.2023.03.124
- EoC associated with three (now retracted) articles: https://doi.org/10.1016/j.ejphar.2021.174471 or https://doi.org/10.1093/milmed/usab504
- EoC flagged in aggregator platform (now retracted): https://explore.lib.uliege.be/permalink/32ULG_INST/9537n7/cdi_proquest_miscellaneous_2680239002

4.5 Article removals

The COPE retraction guidelines state that retracted publications should be unmistakably identified as such in all online sources, and that the retracted status should appear on all online searches for the retracted publication. On extremely rare occasions, however, the publication may need to be removed upon retraction. For example, this may be necessary when:

- Removal of the publication is required by court order.
- The information in the publication may present a risk to personal privacy, a third party's legal rights, or public or environmental health and well-being.
- Information in the publication was published without the required licenses having been obtained.

On the rare occasion when an article is being removed from the published record, the article's metadata (including title and author list) should be retained and should be searchable and publicly available.

Because an article removal can be considered an extension of an editorial decision to retract, the previously discussed overall guidelines for communicating retractions apply to removed work as well: The removed work should be clearly marked as retracted work, and the article removal should be accompanied with a public notice of (retraction and) removal that clearly states the reasons for removal of the article. As removed articles are in principle also retracted, the notice of retraction and the notice of removal can be issued as a single public notice that clarifies both the reasons for retraction and the reasons for removal.

When a digital publication is removed, a "tombstone" webpage should remain publicly accessible. This page should include the article's title, author list, and relevant metadata (see Section 3:), but the main text of the publication should be removed. If a PDF is available for the publication, the PDF should be updated by adding a RETRACTED watermark and removing the main body of the publication plus references, acknowledgments, supplementary material, and so on, so that only the publication title, author list, and relevant metadata remain. An example of a tombstone webpage and truncated PDF file of a retracted and removed publication is available at https://doi.org/10.1371/journal.pone.0219127.

Section 5: Metadata Elements

Metadata elements are classified as either Essential or Recommended. **Essential** metadata elements are those that should be included in every record to ensure the appropriate and timely communication of the issuance of expressions of concern, or the retraction or removal of content. **Recommended** metadata elements are those that would either help to expedite the updating or publication of materials, or provide valuable information for end users in assessing the original publication. Other items are marked as **Essential if Available,** indicating that if the publisher has the information, it should be provided.

5.1 Metadata Elements for the Retracted Publication

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute

Work Title	Essential	Consider adding "RETRACTED" (capitalized) at the beginning of the title so it is clear to users that the work is retracted.
		
		Use "RETRACTED" (in English) whatever the language, the script, or the writing direction (left-to-right or right-to-left) of the retracted work or the publication source.
			`<article-meta>`
			`<title-group>`
			`<article-title>RETRACTED : Original Title</article-title>`
			`</title-group>`
			`</article-meta>`

DOI	Essential if Available	Digital object identifier.	`<article-meta>`
			`<article-id pub-id-type="doi">DOI</article-id>`
			`<article-id pub-id-type="pmid">PMID</article-id>`
			`</article-meta>`

Other Work Identifier(s)	Essential if Available	A unique identifier for an article, such as a PMID or a PMCID. For retracted books or reports, provide the appropriate identifiers (ISBN, eISBN). More than one identifier can be provided.	

Date of Publication	Essential	Publication date of the original work (ISO 8601). This can be a year or a full date with month, day, and year, e.g., yyyy, yyyy-mm, or yyyy-mm-dd.	`<article-meta>`
			`<pub-date>`
			`<day>18</day>`

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
Date of First Availability	Essential if Available	Specify whether this is early access ahead of publication. Date of First Availability may be the same as Date of Publication. At least one date, either Date of Publication or Date of First Availability, should be provided.	<month>5</month> <year>2015</year> </pub-date> </article-meta>
Date of Retraction Notice/EoC	Essential if Available	Republication date of version that includes updated metadata and watermarked PDF, if applicable.	<pub-history> <event event-type="retracted"> <date> <day>18</day> <month>8</month> <year>2023</year> </date> </event> </pub-history> <pub-history> <event event-type="withdrawn"> <date> <day>18</day> <month>8</month> <year>2023</year> </date> </event> </pub-history> <pub-history>

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
			<event event-type="expression-of-concern"> <date> <day>18</day> <month>8</month> <year>2023</year> </date> </event> </pub-history> <pub-history> <event event-type="partial-retraction"> <date> <day>18</day> <month>8</month> <year>2023</year> </date> </event> </pub-history>
Publisher	Essential	Publisher of the original publication that is being retracted.	<journal-meta> <publisher> <publisher-name>Publisher Name</publisher-name> </publisher> </journal-meta>
Publisher Identifier(s) and Publisher ID Provider	Recommended	Publisher ID and source of the publisher ID (e.g., ROR, ISNI, Ringgold).	<publisher> <publisher-name>

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
			<institution-wrap> <institution>Taylor & Francis</institution> <institution-id institution-id-type="ringgold">11888</institution-id> </institution-wrap> </publisher-name> </publisher>
Publication Source	Essential	Journal title or book title. Repeatable field. If applicable, include all titles that are available (e.g., transliterated, translated, official titles in every language printed on document).	<journal-meta> <journal-id journal-id-type="publisher">Journal Title</journal-id> <issn>issn</issn> <issn-l>issn-l</issn-l> </journal-meta>
Publication Source Identifier(s)	Essential	Provide all available identifiers (e.g., eISSN, ISSN, linking ISSN, ISBN, eISBN).	
First Author Full Name	Essential		<contrib contrib-type="author"> <contrib-id contrib-id-type="orcid">ORCID</contrib-id> <name> <surname>Surname</surname> <given-names>Given

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
			Names</given-names> </name> </contrib>
First Author ID	Essential if Available	A unique identifier for an individual author, such as an ORCID.	<contrib-id contrib-id-type="orcid">ORCID</contrib-id>
Indication of Corresponding Author	Essential		<contrib contrib-type="author" corresp="yes">
Other Authors	Essential if Available		<contrib contrib-type="author" corresp="no"> <contrib-id contrib-id-type="orcid">ORCID</contrib-id> <name> <surname>Surname</surname> <given-names>Given Names</given-names> </name> </contrib>
Other Authors' IDs	Essential if Available		
Volume	Essential if Available		<article-meta> <volume>volume</volume> </article-meta>
Issue	Essential if Available		<article-meta> <issue>issue</issue> </article-meta>

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
Start Page/elocation-id	Essential if Available	If an article number is used as an elocation-id instead of pagination, use article number as the start page.	`<article-meta>` `<fpage>first page</fpage>` `</article-meta>`
End Page	Essential if Available		`<article-meta>` `<lpage>last page</lpage>` `</article-meta>`
Funding	Essential if Available	JATS examples of funding metadata are available at https://jats4r.org/funding/.	`<assertion name="funder_name"> National Science Foundation` `<assertion name="funder_identifier">http://dx.doi.org/10.13039/100000001</assertion>` `</assertion>` `<assertion name="award_number">CHE-1152342</assertion>` `</assertion>`
License	Essential if Available	If the original article was published under a specific license, include the licensing information as well as any embargo dates and URL(s) to the license(s). See also: NISO RP-22-2021, Access & License Indicators (2021 Revision).[14]	`<permissions>` `<license>` `<ali:license_ref>URI of license terms</ali:license_ref>` `</license>` `</permissions>`

[14] NISO. (2021b). NISO RP-22-2021, Access & license indicators (2021 revision). https://www.niso.org/publications/rp-22-2021-ali

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
Link Between Retraction Notice/EoC and Original Publication	Essential		<related-article related-article-type="retraction-forward" xlink:href=""/>
Related Items	Essential if Available	Link to related objects such as datasets or preprints.	<related-article xmlns:xlink="http://www.w3.org/1999/xlink" related-article-type=”preprint” ext-link-type="doi" xlink:href="DOI of preprint"> <article-title>Preprint title</article-title> </related-article> <related-object xmlns:xlink="http://www.w3.org/1999/xlink" content-type=”dataset” ext-link-type="doi" xlink:href="DOI dataset"> </related-object>

5.2 Metadata Elements for the Retraction Notice/EoC

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
Article Type	Essential	Identifier for classifying the type of publication: retraction notice or EoC.	<article article-type="retraction"> <article-categories><subj-group subj-group-type="article-type"><subject>Retraction</subject></subj-group></article-categories> <article article-type="expression-of-concern"> <article-categories><subj-group subj-group-type="article-type"><subject>Expression of Concern</subject></subj-group></article-categories> <article article-type="partial-retraction"> <article-categories><subj-group subj-group-type="article-type"><subject>Partial

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
			Retraction</subject></subj-group></article-categories>
Publisher of the Retraction Notice/EoC	Essential		<publisher> <publisher-name>Publisher of retraction notice</publisher-name> </publisher>
Publisher ID and Publisher ID Provider	Recommended	Publisher ID and source of the publisher ID (e.g., ROR, ISNI, Ringgold).	<publisher> <publisher-name> <institution-wrap> <institution>Taylor & Francis</institution> <institution-id institution-id-type="ringgold">11888</institution-id> </institution-wrap> </publisher-name> </publisher>
Publication Source	Essential	Journal title or book title. Repeatable field. If applicable, include all titles that are available (e.g., transliterated, translated, official titles in every language printed on document).	<journal-meta> <journal-id journal-id-type="publisher">Journal Title</journal-id> <issn>issn</issn> <issn-l>issn-l</issn-l> </journal-meta>
Publication Source Identifier(s)	Essential	Provide all available identifiers (e.g., eISSN, ISSN, linking ISSN, ISBN, eISBN).	

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
Volume	Recommended		<article-meta> <volume>volume of retraction notice/EoC</volume> <issue>issue of retraction notice/EoC</issue> <fpage>first page of retraction noticeEoC</fpage> <lpage>last page of retraction noticeEoC</lpage> </article-meta>
Issue	Recommended		
Start Page/elocation-id	Recommended	Start page or elocation-id of the notice.	
End Page	Recommended	End page of the notice.	
Title of Retraction Notice/EoC	Essential	Repeatable field. If applicable, include all titles that are available (e.g., transliterated, translated, official titles in every language printed on document). The retraction notice title should clearly identify the retracted publication, e.g., by including the retracted publication title and authors in the phrase "Retraction of: [article title]."[15] The EoC title should clearly identify the concerned article, e.g., by including the concerned article title and authors in the phrase	<title-group> <article-title>Retraction notice title/Expression of Concern Title</article-title> </title-group>

[15] National Library of Medicine. (2018). Errata, retractions, and other linked citations in PubMed. https://www.nlm.nih.gov/bsd/policy/errata.html

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
		"Expression of concern for: [article title]."[16]	

Date of Retraction Notice/EoC Publication	Essential	Retraction notice/EoC publication date in ISO 8601 format standard.
		
		As best practice, the retraction notice should be published online at the same time that the retracted article is being republished with amended title and watermark.
		
		Time zone can be included if this is part of the publisher's practice.
			`<article-meta>`
			`<pub-date>`
			`<day>08</day>`
			`<month>08</month>`
			`<year>2023</year>`
			`</pub-date>`
			`</article-meta>`
			
			Or
			
			`<article-meta>`
			`<pub-date iso-8601-date="2023-08-08T14:01:00+5:00">`
			`<day>08</day>`
			`<month>08</month>`
			`<year>2023</year>`
			`</pub-date>`
			`</article-meta>`

Cause/Description of Retraction Notice/EoC	Recommended	This item is recommended but not essential due to restrictions on what the publisher may legally be allowed to share about the reason for retraction. Using taxonomies has potential benefits, but could be a barrier to participation if it were required.	`<article-meta>`
			`<custom-meta-group>`
			`<custom-meta vocab="Source of descriptive language or name of taxonomy">`

[16] National Library of Medicine. (2018). Errata, retractions, and other linked citations in PubMed. https://www.nlm.nih.gov/bsd/policy/errata.html

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
		The taxonomy used by Retraction Watch[17] is one of the taxonomies identified/used by group members.	<meta-name>Name of taxonomy or source of descriptive language</meta-name> <meta-value>Reason for retraction</meta-value> </custom-meta> </custom-meta-group> </article-meta>
Retraction Notice/EoC Identifier	Essential if Available	A unique identifier, assigned by the publisher, that is separate from the publication that is being retracted or is the subject of the EoC.	<article-id pub-id-type="publisher-id">publisher ID</article-id>
Retraction Notice/EoC DOI	Essential if Available	The retraction notice/EoC should have its own unique DOI (if available) separate from the DOI of the publication that is retracted or is the subject of the EoC.	<article-id pub-id-type="doi">DOI of retraction notice/EoC</article-id>
Retraction Notice/EoC URL	Essential	The retraction notice/EoC should have its own unique URL, separate from the publication that is retracted or is the subject of the EoC. This can be part of the DOI metadata if the publisher registers DOIs.	
Author(s) of the Retraction Notice/EoC	Recommended	The author of the retraction notice/EoC, rather than the authors of the original retracted publication.	Group authorship:

[17] https://retractionwatch.com/retraction-watch-database-user-guide/retraction-watch-database-user-guide-appendix-b-reasons/; https://publicationethics.org/retraction-guidelines

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute

		The author of the retraction notice/EoC is not necessarily the author of the original publication; it can be a representative for the author(s), the journal editor, the publisher, or a named person at the publisher, depending on the journal policy.
		
		In some cases it may not be possible to specify an author of the retraction notice/EoC, which is why this element is only recommended.
			`<contrib contrib-type="author">`
			`<collab collab-type="editors">Editorial board of Journal</collab>`
			`</contrib>`
			
			Named individual:
			
			`<contrib contrib-type="author">`
			`<name>`
			`<surname>Surname</surname>`
			`<given-names>Given Names</given-names>`
			`</name>`
			`<role>Job title (e.g., Journal editor)</role>`
			`</contrib>`

Retraction Notice/EoC License Information	Recommended	License information of retraction notice/EoC.[18]	`<permissions>`
			`<license>`
			`<ali:free_to_read>`
			
			`<ali:start_date>YYYY-MM-DD</ali:start_date>`
			`</ali:free_to_read>`

Free to Read Tag	Recommended	Retraction notice or EoC should appear in front of paywall, free to read.	

[18] NISO. (2021b). NISO RP-22-2021, Access & license indicators (2021 revision). https://www.niso.org/publications/rp-22-2021-ali

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
		If date included, should be identical to Date of Retraction Notice/EoC Publication.[19]	<ali:license_ref>URI of license terms</ali:license_ref> </license> </permissions>
Link Between Retraction Notice/EoC and Original Publication	Essential	Example from PLOS: https://doi.org/10.1371/journal.pone.0256488. Example from OUP: https://doi.org/10.1093/nar/gkad746	<related-article related-article-type="retracted-article" xlink:href="10.1080/13854046.2012.737027"/> <related-article related-article-type="concerning-article" xlink:href="10.1080/14767058.2017.1372413"/>
Link Between Retraction Notice and Related Works	Recommended	Related works include, e.g., datasets, opinion articles published with the original article.	<related-article xmlns:xlink="http://www.w3.org/1999/xlink" related-article-type=”preprint” ext-link-type="doi" xlink:href="DOI of preprint"> <article-title>Preprint title</article-title> </related-article> <related-object xmlns:xlink="http://www.w3.org/1

[19] NISO. (2021b). NISO RP-22-2021, Access & license indicators (2021 revision). https://www.niso.org/publications/rp-22-2021-ali

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
			999/xlink" content-type=”dataset” ext-link-type="doi" xlink:href="DOI dataset"> </related-object>

5.3 Metadata Elements for a Removed Publication

This section closely mirrors the recommendations in 5.1, as in principle all removed articles are also retracted. Removals can be considered an additional condition on top of the retraction, rather than a completely separate editorial decision (e.g., the work is being removed as part of the retraction decision; the editorial status of the work is *retracted* and the physical/digital status of the work is *removed* following retraction).

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
Work Title	Essential	Consider adding “RETRACTED” (capitalized) at the beginning of the title so it is clear to users that the removed work is retracted.	<article-meta> <title-group> <article-title>Retracted: Original Title</article-title> </title-group> </article-meta>
DOI	Essential if Available	Digital object identifier.	<article-meta> <article-id pub-id-type="doi">DOI</article-id> <article-id pub-id-
Other Work Identifier(s)	Essential if Available	A unique identifier for an work, such as a PMID or a PMCID.	

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
		For retracted books or reports, provide all available identifiers (ISBN, eISBN, etc.).	type="pmid">PMID</article-id> </article-meta>
Abstract	Essential	The abstract of the article should be removed from the metadata.	
Date of Publication	Essential	Publication date of the original work in ISO 8601 format standard. This can be a year or a full date with month, day, and year, example: yyyy, yyyy-mm, or yyyy-mm-dd.	<article-meta> <pub-date> <day>18</day> <month>5</month> <year>2015</year> </pub-date> </article-meta>
Date of Removal	Essential	Republication date of the version with "removed" flags.	<pub-history> <event event-type="removed"> <date> <day>18</day> <month>8</month> <year>2023</year> </date> </event> </pub-history>
Date of First Availability	Essential if Available	Specify whether this is early access ahead of publication. Date of First Availability may be the same as Date of Publication. At least one date, either Date of Publication or "Date of First Availability, should be provided.	

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
Publisher	Essential	The publisher of the original publication that is being retracted.	<journal-meta> <publisher> <publisher-name>Publisher Name</publisher-name> </publisher> </journal-meta>
Publisher Identifier(s) and Publisher ID Provider	Recommended	Publisher ID and source of the publisher ID (e.g., ROR, ISNI, Ringgold).	<publisher> <publisher-name> <institution-wrap> <institution>Taylor & Francis</institution> <institution-id institution-id-type="ringgold">11888</institution-id> </institution-wrap> </publisher-name> </publisher>
Publication Source	Essential	Journal title or book title. Repeatable field. If applicable, include all titles that are available (e.g., transliterated, translated, official titles in every language printed on document).	<journal-meta> <journal-id journal-id-type="publisher">Journal Title</journal-id> <issn>issn</issn> <issn-l>issn-l</issn-l> </journal-meta>
Publication Source Identifier(s)	Essential	Provide all available identifiers (e.g., eISSN, ISSN, linking ISSN, ISBN, eISBN).	
First Author Full Name	Essential		<contrib contrib-type="author">

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
			<contrib-id contrib-id-type="orcid">ORCID</contrib-id> <name> <surname>Surname</surname> <given-names>Given Names</given-names> </name> </contrib>
First Author ID	Essential if Available	A unique identifier for an individual author, such as an ORCID.	<contrib-id contrib-id-type="orcid">ORCID</contrib-id>
Indication of Corresponding Author	Essential		<contrib contrib-type="author" corresp="yes">
Other Authors	Essential if Available		<contrib contrib-type="author" corresp="no"> <contrib-id contrib-id-type="orcid">ORCID</contrib-id> <name> <surname>Surname</surname> <given-names>Given Names</given-names> </name> </contrib>
Other Authors' IDs	Essential if Available	A unique identifier for an individual author, such as an ORCID.	<contrib-id contrib-id-type="orcid">ORCID</contrib-id>

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
Volume	Essential if Available		<article-meta> <volume>volume</volume> </article-meta>
Issue	Essential if Available		<article-meta> <issue>issue</issue> </article-meta>
Start Page/elocation-id	Essential if Available	If an article number is used as an elocation-id instead of pagination, use article number as the start page.	<article-meta> <fpage>first page</fpage> </article-meta>
End Page	Essential if Available		<article-meta> <lpage>last page</lpage> </article-meta>
Funding	Essential if Available	JATS examples of funding metadata are available at https://jats4r.org/funding/.	<assertion name="funder_name"> National Science Foundation <assertion name="funder_identifier">http://dx.doi.org/10.13039/100000001</assertion> </assertion> <assertion name="award_number">CHE-1152342</assertion> </assertion>
License	Essential if Available	Note that following removal of the publication, the license may require updating (e.g., if the article was published under	<permissions> <license> <ali:license_ref>URI of license

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
		a CC-BY-4.0 license and the article is being removed due to data ownership/plagiarism concerns). If the original publication was published under a specific license, include the licensing information as well as any embargo dates and URL(s) to the license(s). See also NISO RP-22-2021, Access & License Indicators (2021 Revision).[20]	terms</ali:license_ref> </license> </permissions>
Link Between Retraction Notice/EoC and Original Publication	Essential		<related-article related-article-type="retraction-forward" xlink:href=""/>
Related Items	Essential if Available	Link to related items such as datasets or preprints. Note that as part of the removal, these related items may also require removal and redirection to a "tombstone" page. Publishers should make reasonable effort to contact the hosts of the related materials and inform them of the article removal.	<related-article xmlns:xlink="http://www.w3.org/1999/xlink" related-article-type="preprint" ext-link-type="doi" xlink:href="DOI of preprint"> <article-title>Preprint title</article-title> </related-article> <related-object xmlns:xlink="http://www.w3.org/1999/xlink" content-

[20] NISO. (2021b). NISO RP-22-2021, Access & license indicators (2021 revision). https://www.niso.org/publications/rp-22-2021-ali

Metadata Element	Essential/ Recommended/ Essential if Available	Description	JATS Element/Attribute
			type=”dataset” ext-link-type="doi" xlink:href="DOI dataset"> </related-object>

Section 6: Implementation

This section documents how to implement the recommendations in specific contexts, showing the flow of actions taken by the parties involved in publishing and disseminating the update.

6.1 Journal/Publisher

When a decision is made to publish an update for a publication, a notice is prepared containing details of the update, following COPE guidelines and the recommendations in this document regarding the referencing of the original publication, included metadata elements, etc.

Updated versions of the original publication are prepared in all formats in which the article was originally made available (PDF, HTML, XML, etc.).

6.2 Web Vendors/Full-text Hosts

Once the notice and any updated publication are available, they should be published simultaneously on the full-text hosting platform.

Metadata, the full text (where applicable) of the notice, and the updated publication (where applicable) should be distributed to any recipients of the original publication using the same mechanisms (e.g., through Crossref metadata deposits, FTP deliveries, web crawlers, etc.).

6.3 Aggregators

Upon receiving updated metadata for an article and an associated notice of an article update, aggregators should reflect the changes to the original publication in a timely manner. They should also include the notice in their databases, with clear bidirectional links between the updated publication and the associated notice. Below are examples from aggregator platforms (Primo VE and Web of Science).

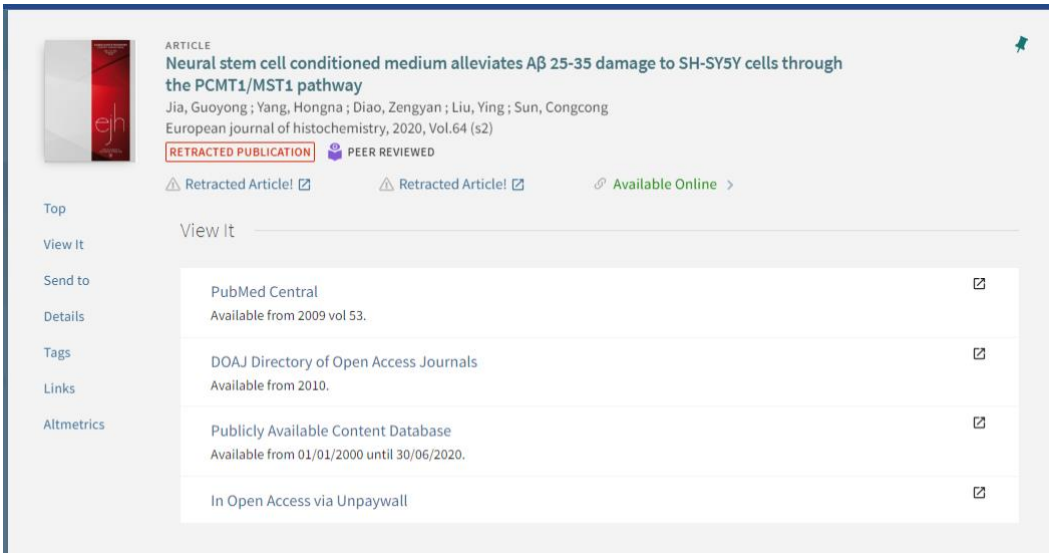


Figure 1: Primo VE example[21]
Source: Primo, provided by Ex Libris, part of Clarivate

[21] https://explore.lib.uliege.be/permalink/32ULG_INST/9537n7/cdi_pubmed_primary_32705859

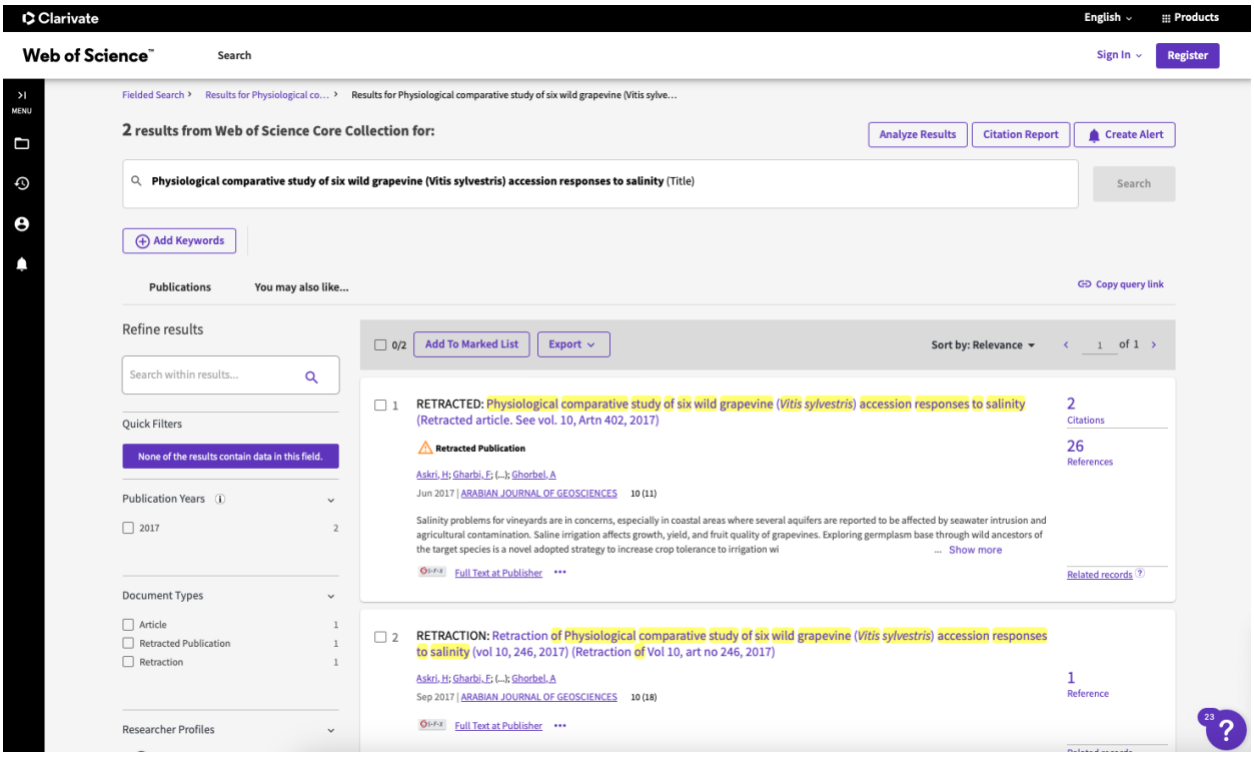


Figure 2: Web of Science example
Source: Data from Web of Science, provided by Clarivate
Web of Science, Primo, Ex Libris, and Clarivate are trademarks of their respective owners and used herein with permission.

Section 7: Known Variations and Complexities

7.1 Pre–Version of Record (VoR) Notices

Sometimes concerns with a publication come to the attention of the journal or publisher at the point at which a version of the publication is already citable (for example, published with a DOI as an accepted manuscript or early publication manuscript), but not yet a finalized version of record. There are a few options for journals to consider here:

Option 1: Keep the article in the "interim" state indefinitely, with the notice applying to this version (i.e., attach the retraction notice to the record).

Option 2: Keep the "interim" article as part of the scholarly record (i.e., attach the record to the retraction notice).

Option 3: Temporarily pause progression of the article to VoR until the concern is resolved, with the assumption that the VoR may subsequently and simultaneously be published with a retraction or correction.

Option 4: Progress the article to a VoR, if there is no way to stop it (due to timing) or if the concern is shown to have no merit.

This document does not aim to recommend which of these (or other) options is most appropriate, but does recommend that:

- Transparency be maintained, so the scholarly record can be reconstructed by readers (i.e., it is clear what the concern is/was and to what it applied).
- The previously stated recommendations regarding metadata and display can be upheld.
- Citation integrity is preserved (meaning that if the article is cited, there is a way for a person looking at that citation to discover that it has been retracted and that the article itself is still discoverable).

7.2 Journals with Issue-based Publishing

The recommendations in this document also apply for journals that publish in issues (rather than continuously) without online-first publication. This can lead to cases where article notices published as content items in their own right may have to wait for the next available issue to be published.

In this context, we recommend that a retraction or removal notice, or an EoC, be made publicly available as soon as possible, e.g., on the publisher or publication website, and then published in the next issue when it is made available online and in print.

7.3 Journals that Have Ceased Publishing with No Accountable Entity

Occasionally, concerns with content arise after a journal has ceased publishing. If there is no accountable entity for the publication, e.g., the publisher has also ceased operations, there may be no mechanism to create a notice with associated metadata for the content.

7.4 Journals that Have Ceased Publishing with an Accountable Entity

In the case of journals that are no longer published but the publisher is still in operation, the publisher retains the responsibility for updating the content and following the recommendations set forward in this document. We note that we do not attempt to advise on how investigations or editorial decisions can be

made in this context; rather, we focus on the communication and display of the retraction or removal notice or EoC.

7.5 Publications that Have Transferred to Another Publisher

Occasionally, concerns arise relating to content that was published under the aegis of one publisher and is now under new ownership or management. A journal that has moved to another publisher can introduce several complexities to communication and display. For example, the new publisher may not be able to easily edit archived files transferred from a previous publisher, to watermark a retracted publication or alter title metadata.

In these scenarios, we recommend best efforts are made by the current publisher to:

- Clearly indicate the article's status following the recommendations in this document, working with the previous publisher if relevant, especially in instances where the content may be published on both the previous and new publisher sites.
- Notify third parties such as aggregators, using existing mechanisms such as the resupply of updated metadata to communicate the update(s) to the content.

As part of the transfer process, it is also important that retraction notices and other updates, and their associated metadata and links, are transferred between publishers as part of the transfer process.

Appendix A
Proposed Flowcharts and Scenarios

A visual depiction of the recommendations for retractions is shown below.

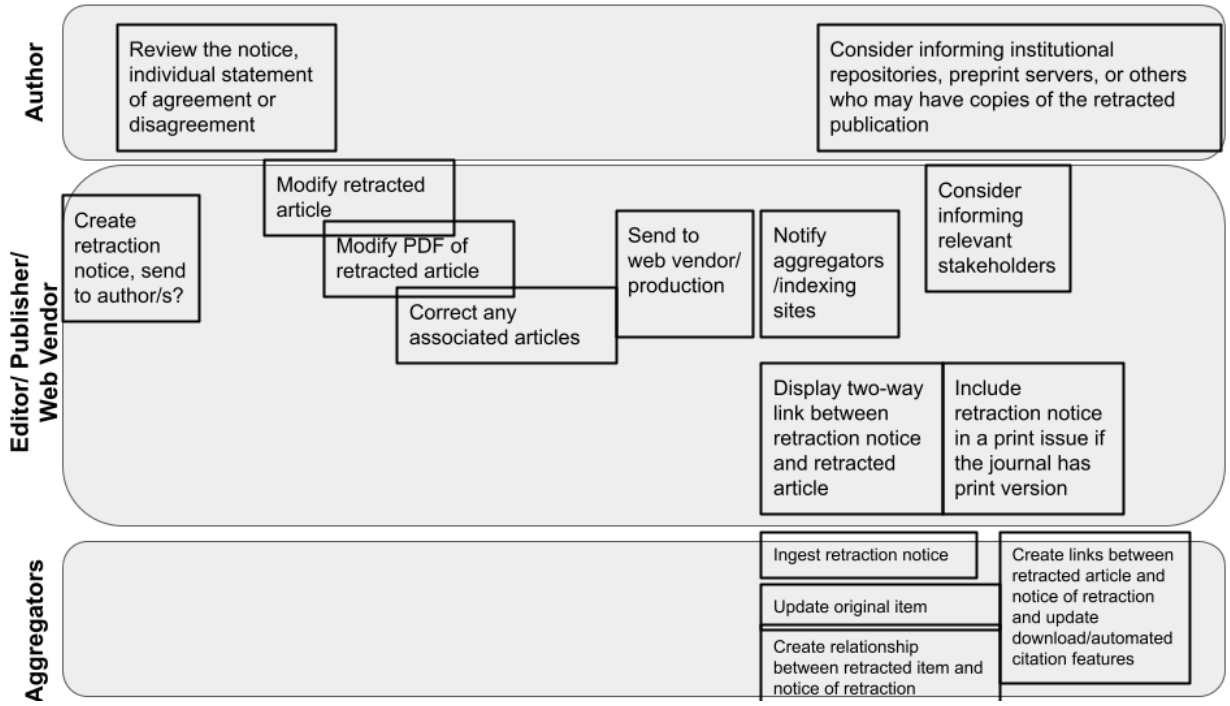


Figure 1: Retraction Communication Flowchart

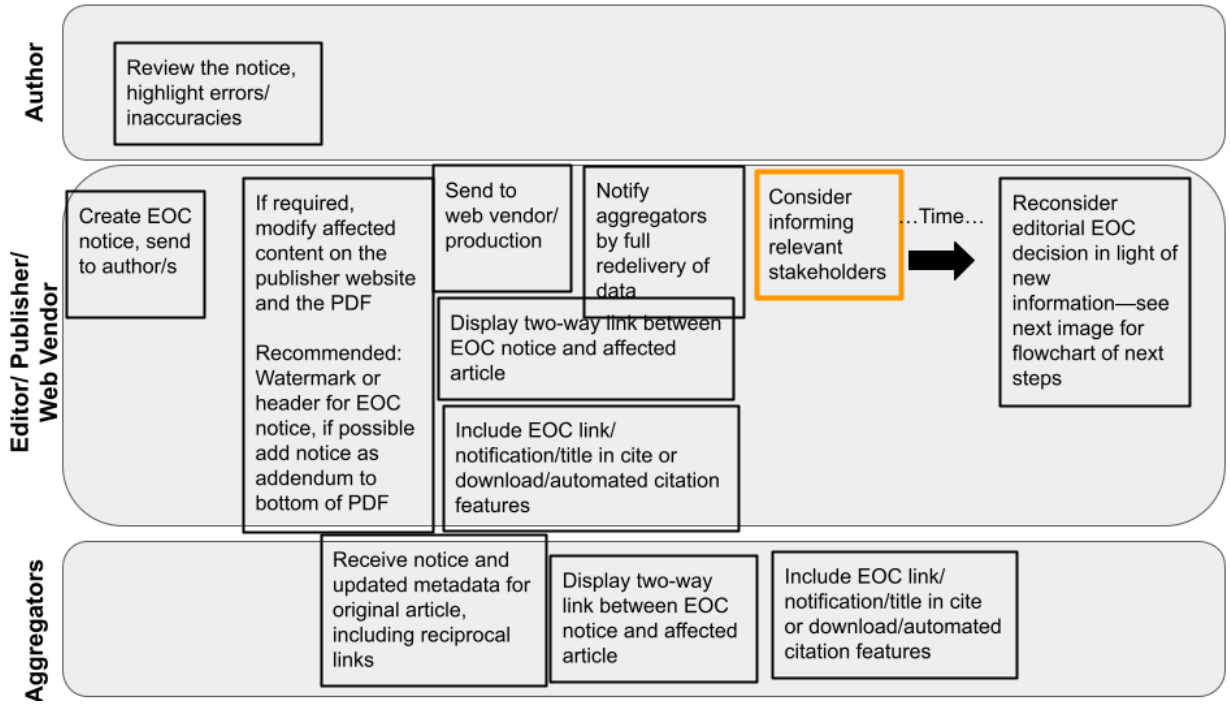
A table listing which parties should be responsible for, accountable for, consulted on, and informed of these actions is shown below.

Table 1: RACI: Responsible, Accountable, Consulted, Informed

Phases	Author	Publisher/ Editor/Vendor	Aggregator
Review the notice, individual statement of agreement or disagreement		R	
Consider informing institutional repositories, preprint servers, or others who may have copies of the retracted publication		R	
Create a retraction notice, send to author/s?	C/I	R	
Modify retracted article	C	R	I
Modify PDF of retracted article		R	

Correct any associated articles		R	
Send to web vendor/production	I	R	
Notify aggregators/indexing sites		R	I
Consider informing relevant stakeholders	I	R	
Ingest retraction notice		A	R
Update original item		R	I
Create relationship between retracted item and notice of retraction		R	I
Create links between retracted article and notice of retraction		R	I
Display two-way link between retraction notice and retracted article		R	R

Scenarios related to EoCs are shown below.



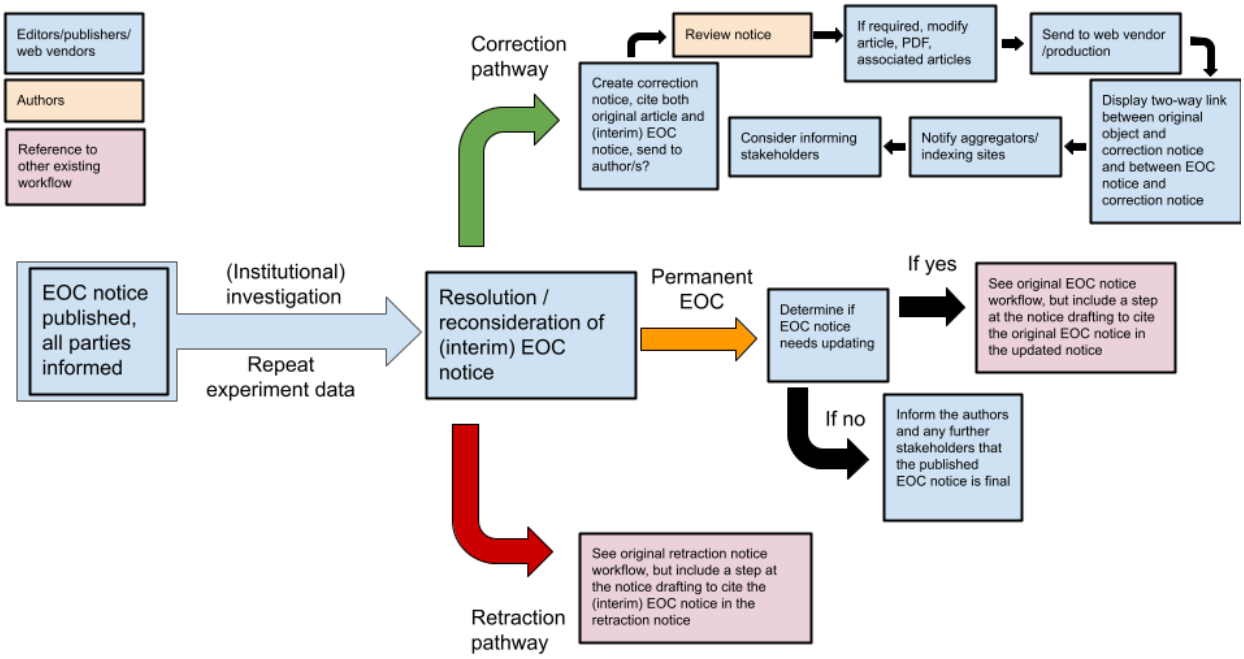


Figure 2: EoC Flowchart

Appendix B
Examples of Metadata Elements

B.1 JATS Metadata (Retracted Article)

The original article, if available for update, will have the article title updated, addition of the date of the retraction and a link to the retraction notice. A hosting platform may allow a publisher to not update the original article and automatically link the retraction notice to the article. Similarly, Crossref and other article registration entities can also perform that linking; however, for consistency of the record, always update the original article metadata.

```
<article article-type="research-article">
      <journal-meta>
            <journal-id journal-id-type="publisher">Journal title</journal-
id>
            <issn>issn</issn>
            <issn-l>issn-l</issn-l>
            <publisher>
                  <publisher-name>Publisher of original article</publisher-
name>
            </publisher>
      </journal-meta>
      <article-meta>
            <article-id pub-id-type="doi">DOI of original article</article-
id>
            <title-group>
                  <article-title>RETRACTED: Title of the retracted
article</article-title>
            </title-group>
            <!-- Article keeps original publication date -->
            <pub-date pub-type="pub" iso-8601-date="YYYYMMDD">
                  <day>DD</day>
                  <month>MM</month>
                  <year iso-8601-date="YYYY">YYYY</year>
            </pub-date>
            <volume>volume of original article</volume>
            <issue>issue of original article</issue>
            <fpage>first page of original article</fpage>
            <lpage>last page of original article</lpage>
            <!-- If the original article can be updated, add the following --
>
            <history>
                  <date date-type="retracted" iso-8601-date="YYYYMMDD">
                        <day>DD</day>
                        <month>MM</month>
                        <year iso-8601-date="YYYY">YYYY</year>
                  </date>
            </history>
            <related-article xmlns:xlink="http://www.w3.org/1999/xlink"
related-article-type="retracted-forward" ext-link-type="doi" xlink:href="DOI
of retraction notice">
                  <article-title>Retraction notice article title</article-
title>
```

```
            </related-article>
            <related-article xmlns:xlink="http://www.w3.org/1999/xlink"
      related-article-type=”preprint” ext-link-type="doi" xlink:href="DOI of
      preprint">
                  <article-title>Preprint title</article-title>
            </related-article>
            <related-object xmlns:xlink="http://www.w3.org/1999/xlink"
      content-type=”dataset” ext-link-type="doi" xlink:href="DOI dataset">
            </related-object>
      </article-meta>
```

B.2 JATS Metadata (Retracted Article)

The retraction notice must always include a relationship to the retracted article. The affected work must always include a relationship link to the retraction notice or EoC.

```
<article article-type="retraction">
      <journal-meta>
            <journal-id journal-id-type="publisher">Journal title</journal-
id>
            <issn>issn</issn>
            <issn-l>issn-l</issn-l>
            <publisher>
                  <publisher-name>Publisher of retraction notice</publisher-
name>
            </publisher>
      </journal-meta>
      <article-meta>
            <article-id pub-id-type="doi">DOI of retraction notice</article-
id>
            <title-group>
                  <article-title>Retraction notice title</article-title>
            </title-group>
            <contrib contrib-type="author">
                  <name>
                  <surname>Surname</surname>
                  <given-names>Given names</given-names>
                  </name>
                  <role>Job title (e.g., Journal editor)</role>
            </contrib>
            <pub-date pub-type="pub" iso-8601-date="YYYYMMDD">
                  <day>DD</day>
                  <month>MM</month>
                  <year iso-8601-date="YYYY">YYYY</year>
            </pub-date>
            <volume>volume of retraction notice</volume>
            <issue>issue of retraction notice</issue>
            <fpage>first page of retraction notice</fpage>
            <lpage>last page of retraction notice</lpage>
            <related-article xmlns:xlink="http://www.w3.org/1999/xlink"
related-article-type="retracted-article" ext-link-type="doi" xlink:href="DOI
of retracted article">
                  <article-title>Article title being retracted</article-
title>
            </related-article>
```

```
            <related-article xmlns:xlink="http://www.w3.org/1999/xlink"
      related-article-type=”preprint” ext-link-type="doi" xlink:href="DOI of
      preprint">
                  <article-title>Preprint title</article-title>
            </related-article>
            <related-object xmlns:xlink="http://www.w3.org/1999/xlink"
      content-type=”dataset” ext-link-type="doi" xlink:href="DOI dataset">
            </related-object>
      </article-meta>
</article>
```

B.3 Crossref Metadata (Retracted Article)

Example generated from the following citation:

Liang, L., Beina, H. RETRACTED ARTICLE: Simulation of rainfall process in mountainous regions and sports athletes' fatigue recovery based on convolutional neural network. *Arab J Geosci* 14, 982 (2021). https://doi.org/10.1007/s12517-021-07364-0

```
<journal>
  <journal_metadata language="en">
    <full_title>Arabian Journal of Geosciences</full_title>
    <abbrev_title>Arab J Geosci</abbrev_title>
    <issn media_type="print">1866-7511</issn>
    <issn media_type="electronic">1866-7538</issn>
  </journal_metadata>
  <journal_issue>
    <publication_date media_type="print">
      <month>06</month>
      <year>2021</year>
    </publication_date>
    <journal_volume>
      <volume>14</volume>
    </journal_volume>
    <issue>11</issue>
  </journal_issue>
  <journal_article publication_type="full_text">
    <titles>
      <title>RETRACTED ARTICLE: Simulation of rainfall process in mountainous
      regions and sports athletes' fatigue recovery based on convolutional
      neural network</title>
    </titles>
    <contributors>
      <person_name contributor_role="author" sequence="first">
        <given_name>Luo</given_name>
        <surname>Liang</surname>
      </person_name>
      <person_name contributor_role="author" sequence="additional">
        <given_name>He</given_name>
        <surname>Beina</surname>
      </person_name>
    </contributors>
    <publication_date media_type="online">
      <month>05</month>
      <day>26</day>
      <year>2021</year>
```

```
    </publication_date>
    <publication_date media_type="print">
      <month>06</month>
      <year>2021</year>
    </publication_date>
    <publisher_item>
      <item_number item_number_type="article-number">982</item_number>
      <identifier id_type="pii">7364</identifier>
    </publisher_item>
    <crossmark>
      <crossmark_version>1</crossmark_version>
      <crossmark_policy>10.1007/springer_crossmark_policy</crossmark_policy>
      <crossmark_domains>
        <crossmark_domain>
          <domain>link.springer.com</domain>
        </crossmark_domain>
      </crossmark_domains>
      <crossmark_domain_exclusive>false</crossmark_domain_exclusive>
      <updates>
        <update date="2021-09-28" type="expression_of_concern">10.1007/s12517-
        021-07364-0</update>
        <update date="2021-11-09" type="retraction">10.1007/s12517-021-07364-
        0</update>
      </updates>
      <custom_metadata>
        <assertion group_label="Article History" group_name="ArticleHistory"
        label="Change Type" name="change_type" order="5">Correction</assertion>
        <assertion group_label="Article History" group_name="ArticleHistory"
        label="Change Details" name="change_details" order="6">This article has
        been retracted. Please see the Retraction Notice for more
        detail:</assertion>
        </custom_metadata>
    </crossmark>
    <doi_data>
      <doi>10.1007/s12517-021-07364-0</doi>
      <timestamp>20211109055958105</timestamp>
      <resource
      content_version="vor">https://link.springer.com/10.1007/s12517-021-
      07364-0</resource>
      </collection>
    </doi_data>
```

B.4 Crossref Metadata (Retraction Notice)

Example generated from the following citation:

Liang, L., Beina, H. Retraction Note to: Simulation of rainfall process in mountainous regions and sports athletes' fatigue recovery based on convolutional neural network. *Arab J Geosci* 14, 2367 (2021). https://doi.org/10.1007/s12517-021-08835-0

```
<journal>
  <journal_metadata language="en">
    <full_title>Arabian Journal of Geosciences</full_title>
    <abbrev_title>Arab J Geosci</abbrev_title>
```

```
  <issn media_type="print">1866-7511</issn>
  <issn media_type="electronic">1866-7538</issn>
</journal_metadata>
<journal_issue>
  <publication_date media_type="print">
    <month>11</month>
    <year>2021</year>
  </publication_date>
  <journal_volume>
    <volume>14</volume>
  </journal_volume>
  <issue>22</issue>
</journal_issue>
<journal_article publication_type="full_text">
  <titles>
    <title>Retraction Note to: Simulation of rainfall process in mountainous
    regions and sports athletes’ fatigue recovery based on convolutional
    neural network</title>
  </titles>
  <contributors>
    <person_name contributor_role="author" sequence="first">
      <given_name>Luo</given_name>
      <surname>Liang</surname>
    </person_name>
    <person_name contributor_role="author" sequence="additional">
      <given_name>He</given_name>
      <surname>Beina</surname>
    </person_name>
  </contributors>
  <publication_date media_type="online">
    <month>11</month>
    <day>09</day>
    <year>2021</year>
  </publication_date>
  <publication_date media_type="print">
    <month>11</month>
    <year>2021</year>
  </publication_date>
  <publisher_item>
    <item_number item_number_type="article-number">2367</item_number>
    <identifier id_type="pii">8835</identifier>
  </publisher_item>
  <crossmark>
    <crossmark_version>1</crossmark_version>
    <crossmark_policy>10.1007/springer_crossmark_policy</crossmark_policy>
    <crossmark_domains>
      <crossmark_domain>
        <domain>link.springer.com</domain>
      </crossmark_domain>
    </crossmark_domains>
    <crossmark_domain_exclusive>false</crossmark_domain_exclusive>
    <custom_metadata>
      <assertion group_label="Article History" group_name="ArticleHistory"
      label="First Online" name="first_online" order="1">9 November
      2021</assertion>
      <assertion label="Free to read" name="free">This content has been made
      available to all.</assertion>
```

```
    <ai:program xmlns:ai="http://www.crossref.org/AccessIndicators.xsd"
    name="AccessIndicators">
      <ai:free_to_read start_date="2021-11-25"/>
      <ai:license_ref
      applies_to="tdm">https://www.springer.com/tdm</ai:license_ref>
      <ai:license_ref
      applies_to="vor">https://www.springer.com/tdm</ai:license_ref>
    </ai:program>
  </custom_metadata>
</crossmark>
<doi_data>
  <doi>10.1007/s12517-021-08835-0</doi>
  <timestamp>20211125120635660</timestamp>
  <resource
  content_version="vor">https://link.springer.com/10.1007/s12517-021-
  08835-0</resource>
    </item>
  </collection>
</doi_data>
```

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