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Outputs of the NISO Alternative Assessment Metrics Project

A Recommended Practice of the National Information Standards Organization

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Foreword

About this Recommended Practice

Altmetrics are increasingly being used and discussed as an expansion of the tools available for measuring the scholarly impact of research in the knowledge environment. The NISO Alternative Assessment Metrics Project was begun in July 2013 with funding from the Alfred P. Sloan Foundation to address several areas of limitations and gaps that hinder the broader adoption of altmetrics. This document, the output from the project, was created by three working groups.

- "Working Group A" extensively studied the altmetrics literature and other communications and discussed in depth various stakeholders' perspectives and requirements for these new evaluation measures.
- "Working Group B" created documents that are intended to help users better understand the landscape of data metrics and thus offer recommendations toward improvements, and to help organizations that wish to use altmetrics effectively communicate about them with each other and with those outside the community.
- "Working Group C" studied and discussed issues of data quality in the altmetrics realm, an essential aspect of evaluation before metrics can be used for research and practical purposes.

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Section 1: Altmetrics Definitions and Use Cases

1.1 Purpose and Scope

This section represents the output of the working group tasked with the following action items:

1. To come up with specific definitions for the terms commonly used in alternative assessment metrics, enabling different stakeholders to talk about the same thing.
2. To identify the main use cases for altmetrics and the stakeholder groups to which they are most relevant, and to develop a statement about the role of alternative assessment metrics in research evaluation.

1.2 A Definition of Altmetrics

Over the past several years, as altmetrics has developed as a practice, some terms and conventions have emerged among stakeholders. Below is a discussion of how various terms are understood by these practitioners.

1.2.1 What is Altmetrics?

Altmetrics is a broad term that encapsulates the collection of multiple digital indicators related to scholarly work. These indicators are derived from activity and engagement among diverse stakeholders and scholarly outputs in the research ecosystem, including the public sphere.

The inclusion in the definition of altmetrics of many different outputs and forms of engagement helps distinguish it from more established citation based metrics. At the same time, it leaves open the possibility of the complementary use of these conventional metrics, including for purposes of gauging scholarly impact. However, the development of altmetrics in the context of alternative assessment sets its measurements apart from conventional instances of citation-based scholarly assessment.

1.2.2 Scholarly Impact and the Role of Altmetrics in Research Evaluation

Scholarly impact is a concept based largely upon the values of different research stakeholders, and continues to evolve over time. Clarifying the concept of impact within the context of a given community is therefore important in avoiding misinterpretations of altmetrics. As such, to avoid being overly limiting, we focus on the current and potential uses for altmetrics, including its use in research evaluation.

The diversity of stakeholders, and the diverse ways of being impactful, makes a narrow definition of impact impractical. For stakeholders invested in conventional methods of scholarly communication, impact may be synonymous with citation based metrics, while for stakeholders with strong interests in societal change, such metrics may be inadequate indicators of impact. For stakeholders interested in the broad influence of scholarly outputs, altmetrics may offer insight into impact by calculating an output's reach, social relevance, and attention from a given community, which may include members of the public sphere.

Citations, usage, and altmetrics are all important and imperfect indicators of the values reflected by the term scholarly impact. Just as with conventional citation based assessments, it is inadvisable to use altmetrics as an uncritical proxy for scholarly impact because the attention paid to a research output or the rate of its dissemination may be unclear until combined with qualitative information.

Additionally, it is important to recognize that data quality and indicator construction are key factors in the evaluation of specific altmetrics. Indicators that do not transparently conform to recommended standards are difficult to assess, and thus may be seen as less reliable for purposes of measuring influence or evaluation. Likewise, the manner in which indicators are presented within relevant tools has an important effect on the ability of users to evaluate altmetrics and on evaluating the usefulness of altmetrics. For example, if it is straightforward to benchmark the altmetrics of an article with those of other similar articles to help judge whether performance is strong, this contributes to the positive evaluation of altmetrics.

1.3 Main Use Cases

Use cases for altmetrics are driven by the different stakeholders in the research ecosystem, many of whom interact directly with one another, and some of whom overlap on an individual basis—as in the case of a researcher who is also a member of a hiring committee. The deployment of personas helps to highlight the different ways that these stakeholders collect, develop, and consume altmetrics, as well as the potential commonalities between altmetrics' stakeholders' needs, goals, and usages.

The following table presents some of the major use cases for altmetrics by describing eight primary stakeholder personas. There may be interrelationships between personas, as one person can serve many roles, and those roles can interact with each other. To further explain and contextualize the relationships between the stakeholders, each use case has been tagged according to three overarching themes.

1. **Showcase achievements:** Indicates stakeholder interest in highlighting the positive achievements garnered by one or more scholarly outputs.
2. **Research evaluation:** Indicates stakeholder interest in assessing the impact or reach of research.
3. **Discovery:** Indicates stakeholder interest in discovering or increasing the discoverability of scholarly outputs and/or researchers.

1.3.1 Persona #1: Librarians

Persona	Use case	Theme(s)
As a librarian, I want to…	Add value to my existing institutional repositories by encouraging researchers to deposit their works. For example, by creating a report to showcase frequency of views and downloads.	Showcase achievements
	Showcase the performance of my institution's scholarly outputs (or the outputs of a particular author).	Showcase achievements
	Increase authors' awareness of the scholarly and societal impacts of their scholarly outputs, as well as increase institutional awareness of such outputs in general.	Showcase achievements
	Monitor usage and decide to which journals and content my institution should subscribe.	Discovery Research evaluation
	Support both faculty and the university administration in their promotion and tenure exercises by offering a range of recognized impact-report services.	Showcase achievements Research evaluation
	Advise faculty/researchers on possible ways to improve upon the attention paid toward, and reach of, their work.	Showcase achievements Discovery

1.3.2 Persona #2: Research Administrators

Persona	Use case	Theme(s)
As a research administrator, I want to…	Showcase the achievements of my organization to other stakeholders. For example, I want to demonstrate the achievements of my institution's researchers to potential hires, students, collaborators, and other researchers.	Showcase achievements
	Support researchers in applying for competitive funding by effectively showcasing positive achievements of their research outputs.	Showcase achievements
	Gauge the performance and achievements of my institution's scholarly outputs.	Research evaluation

	Predict and determine the return on investment of my institution's research.	Research evaluation
	Compare/benchmark the performance and achievements of departments and/or groups within my institution.	Research evaluation
	Identify potential collaborators at other institutions with whom to partner with on grant applications and other projects.	Discovery

1.3.3 Persona #3: Member of a Hiring Committee

Persona	**Use case**	**Theme(s)**
As a member of a hiring committee, I want to…	Showcase my institution or organization in the best light to potential recruits.	Showcase achievements
	Evaluate potential employees and assess their achievements on the broadest range of aspects possible.	Research evaluation
	Identify new talent whom I may want to recruit.	Discovery

1.3.4 Persona #4: Member of a Funding Agency

Persona	**Use case**	**Theme**
As a member of a funding agency, I want to…	Evaluate the previous achievements of academics/researchers who are applying for funding.	Research evaluation
	Evaluate the broader impacts (attention drawn, engagement caused, or influence) of research that I funded. For example, citations in media reports are influential to policy makers and general public.	Research evaluation
	Identify trends in public interest or need, or new and emerging topics, so that I can decide in which research areas to invest.	Discovery
	Showcase the returns of investment of my organization to other stakeholders by, for example, • Demonstrating to the general public that their donations have been used appropriately and effectively. • Showing politicians and government bodies that their funding has been used appropriately and effectively.	Showcase achievements

1.3.5 Persona #5: Academics / Researchers

Persona	Use case	Theme(s)
As an academic or researcher, I want to…	Assess the reach, engagement, and influence of my own research outputs, by, for example, incorporating altmetrics in my portfolio to complement my other accomplishments.	Showcase achievements
	Assess the reach, engagement with, and influence of the research outputs of my peers, by, for example, writing a letter for the tenure of a researcher at another university.	Research evaluation
	Comply with reporting requests or mandates from funders, department heads, research administrators, etc.	Research evaluation
	Choose to publish in a journal that will provide the maximum exposure of my work to relevant audiences.	Discovery
	Choose to contribute to a publication whose metrics or qualitative data can be tracked to help me assess the reach, engagement with, and influence of my work.	Research evaluation Showcase achievements
	Discover influential research that is important/interesting in my field.	Discovery
	Identify potential collaborators and connections between research.	Discovery
	Discover where research is being discussed and potentially join into the conversation.	Discovery

1.3.6 Persona #6: Publishers / Editors

Persona	Use case	Theme(s)
As a publisher or editor, I want to…	Demonstrate the reach, engagement with, and influence of research published in my journal.	Showcase achievements
	Use insights from attention assessment and other metrics to help make editorial decisions about themes or topics upon which to focus.	Research evaluation
	Encourage authors to publish in my journal by providing them with information on attention, metrics, and other qualitative information about their research. For example, I	Showcase achievements

	want to encourage authors to publish in my journal by demonstrating the promotional efforts that can be made by my publication on behalf of the authors.	Research evaluation
	Identify general trends that the public is interested in so that I can decide what research areas to target in future publications.	Discovery

1.3.7 Persona #7: Media Officers / Public Information Officers / Journalists

Persona	Use case	Theme(s)
As a media officer, public information officer, or journalist, I want to…	Promote research that my institution or organization has produced, in order to maximize reach and engagement. For example, I want to encourage people to interact with a blog post that someone has written about a major research study.	Showcase achievements
	Determine whether my press campaigns about my institution's or publication's research output have been successful.	Showcase achievements
	Discover ways to enhance the exposure of my institution's or publication's research outputs.	Discovery Showcase achievements
	Identify popular and newsworthy papers or topics to cover.	Discovery

1.3.8 Persona #8: Content Platform Provider

Persona	Use case	Theme(s)
As a content platform provider, I want to…	Help readers to find content that is interesting, useful, and/or relevant to them by showing them the conversations about that content. For example, I want to offer sorting, filtering, limiting, etc. according to the attention given to that subject by various audiences, or according to the discussion generated by it on certain media platforms.	Discovery
	Help authors to see an aggregated view and analysis of all the attention, metrics, and qualitative information about their research.	Showcase achievements

Section 2: Alternative Outputs in Scholarly Communications

2.1 Background and Context

The NISO Persistent Identifiers and Alternative Outputs Working Group investigated alternative research outputs and application of persistent identifiers in the scholarly environment in order to clearly identify and track research outputs and their relationships. The composition of the Working Group was developed to represent a balance of parties that are interested in unconventional research outputs and identifiers, with just under half of the members coming from academic institutions and libraries. Publishers and other organizations in the scholarly ecosystem make up the majority of the rest of the group's membership. The organizations represented are drawn from bodies that have an interest in research output metrics.

2.2 Alternative Scholarly Outputs

The NISO Scholarly Outputs table (see Google document at https://sites.google.com/a/niso.org/scholarlyoutputs/) is a first attempt at a comprehensive list of research outputs, including the traditional academic publication and extending to more alternative outputs. These outputs may fall within the scope of assessment when developing metrics to evaluate the impact of scholarly activity, with the acknowledgement that meaningful impact can go far beyond conventional publishing workflows and often involves the rich array of scholarly products that are created during the research process. These output types are grouped by class and alphabetized with a brief description and documentation of known current efforts (and by whom they are being undertaken). Relevant links are listed where available, and most entries have been assigned a focus area to group them by similar contextual uses. The focus areas are: Basic Sciences; Capacity; Code and Software; Communications; Data; Education and Training Materials; Events; Grey Literature; Images, Diagrams, and Video; Industry; Instruments, Devices, and Inventions; Methodologies, Publications; Regulatory, Compliance, and Legislation; Standards; and Other.

This work is not complete, as the very nature of scholarly activity continually evolves. However, the rich array of outputs represented in this table help to better establish the breadth and depth of scholarly work that may be produced by an investigator or by a research team. Through this effort, the working group hopes to generate discussion about how we may begin to leverage integrated data, persistent identifiers, and automated workflows to better capture and track the full complement of research activity, as is possible for publication data.

2.3 Implications for Future Research

Future work in this area requires a more comprehensive inventory of output types and the work presented here can serve as a springboard for these efforts to gain their perspectives about research outputs of interest (e.g., in the UK and Australia). This future comprehensive inventory should include additional stakeholders, including funders from countries where research assessment exercises are underway. Other key areas of work include the integration of various research assessment frameworks[1]; a formal assessment of the extent of nontraditional research output types not

[1] Graham, K.E.R., H.L. Chorzempa, P.A. Valentine, & J. Magnan. "Evaluating Health Research Impact: Development and Implementation of the Alberta Innovates – Health Solutions Impact Framework." *Research Evaluation* 2012; 21(5):354-67. doi: 10.1093/reseval/rvs027.

yet managed with persistent identifiers, but necessary for long-term management of access and relationships; and creation of a priority list for incorporating these output types into existing information systems across the research spectrum and workflow. These activities could help guide development of comprehensive alternative metrics measures and methodologies reaching far beyond the traditional academic publication.

Manville C., S. Guthrie, M.-L. Henham, B. Garrod, S. Sousa, A. Kirtley, S. Castle-Clarke, & T. Ling. "Assessing impact submissions for REF2014: An evaluation." Product Page. Santa Monica, CA: RAND Corporation, 2015 April 17. Report No.: RR-1032-HEFCE.

Morgan Jones, M. & J. Grant. "Making the Grade: Methodologies for Assessing and Evidencing Research Impact." In: Dean A, Wykes M, Stevens H, editors. *7 Essays on Impact*. Exeter, UK: University of Exeter; 2013.

Panel on Return on Investment in Health Research, 2009. *Making an Impact: A Preferred Framework and Indicators to Measure Returns on Investment in Health Research*. Canadian Academy of Health Sciences, Ottawa, ON, Canada. http://www.cahs-acss.ca/wp-content/uploads/2011/09/ROI_FullReport.pdf

Sarli, C.C., E.K. Dubinsky, & K.L. Holmes. "Beyond Citation Analysis: A Model for Assessment of Research Impact." *Journal of the American Medical Library Association* 98, no. 1 (2010):17-23. doi:10.3163/1536-5050.98.1.008. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2801963/

Section 3: Study and Recommendations on Data Metrics

3.1 Summary

Working Group B, formed to address work areas related to unconventional research outputs and identifiers, first focused efforts upon a better understanding of data metrics. This focus is especially timely given the emphasis placed upon open science approaches, as well as mandates by funders to make research products openly accessible. This section of the Recommended Practice describes the current state of data citations, as determined through a series of conversations with key stakeholder organizations such as CASRAI, DataCite, JISC, and others; representatives from other ongoing efforts; and within the working group itself. Section 3 also presents a set of recommendations for data metrics, directed toward the spectrum of groups working with research data, including institutions and repository managers, international research organizations, and funders.

3.2 Key recommendations

- Metrics on research data should be made available as widely as possible.
- Data citations should be implemented following the Force11 *Joint Declaration of Data Citation Principles* (https://www.force11.org/group/joint-declaration-data-citation-principles-final), in particular:
    - Use machine-actionable persistent identifiers
    - Provide metadata required for a citation
    - Provide a landing page
    - Data citations should go into the reference list or similar metadata.
- Standards for research-data-use statistics need to be developed. They should be based on the COUNTER Code of Practice (https://www.projectcounter.org/code-of-practice-sections/general-information/) but should also take into consideration some special aspects of research data usage. There should be two formulations for data download metrics, to examine both “human” downloads and research-focused non-human agents.
- Research funders should provide mechanisms to support data repositories in implementing standards for interoperability and obtaining metrics.
- Data discovery and sharing platforms should support and monitor “streaming” access to data via API queries.

There have been recent attempts to define and identify large-scale data queries, but there is, as yet, no consensus in this area. This form of data is therefore explicitly excluded from these recommendations. For more on this group’s recommendations, see “Findings” (3.6).

3.3 Background and Context

Research data is now understood to be a primary goal of academic endeavor. This section of the Recommended Practice reports on the state of metrics relating to published research data, and makes recommendations to those stakeholders operating in this area of work.

Publishing datasets is an integral part of scholarly communication, and libraries need to consider digital datasets alongside journal articles and other resources. However, it has been reported that data are often used in publications without being properly cited. One of the reasons for lack of data citation in the literature is the lack of standards for data publication. In order to increase the visibility of datasets, the international consortium known as DataCite (https://www.datacite.org) was created. It allocates unique digital object identifiers (DOIs) and metadata for digital and physical objects with a focus on research data. The unique identifiers and associated metadata provided by DataCite should promote a culture of reusing data as there is a significant correlation between data documentation quality and data reuse satisfaction. However, the absence of widely accepted rules for citing data as separate academic artifacts has been identified as a significant reason behind the lack of research data citations. In response to the challenge, in 2014 FORCE11: The Future of Research Communication and e-Scholarship and others published the *Joint Declaration of Data Citation Principles* with the aim of increasing data citation adoption.

Researchers have been attempting to measure the research impact of datasets for the last two decades. In recent years, scientometricians, researchers in various domains, and funding organizations have explored ways to capture the metrics around datasets to use as evidence for identifying the research impact of data. The main motivation for capturing data citations is to credit scientists and data publishers for their contribution in creating, managing, and curating research data, and to provide evidence of reuse to funders.

Linking datasets to other forms of publications and growing transparency in scholarly communication ecosystem are additional major reasons for measuring metrics around datasets. Although measuring impacts of research data is complicated, some efforts have started to identify data citations. From a conventional citation based perspective, Thomson Reuters launched the Data Citation Index (http://wokinfo.com/products_tools/multidisciplinary/dci) in 2012, which indexes datasets and their citations from main repositories across different disciplines. Using statistics for searches, viewing, and downloads, Ingwersen and Chavan[2] suggested a Data Usage Index, which could reveal the impact of datasets from novel points of view. In the same way, Fear[3] came to a conclusion that the impact of scholarly datasets cannot be measured through a single indicator, and as a result, suggested multiple metrics for measuring the value of datasets. Strasser, Kratz, and Lin[4] reported that data citation was still underused, and that the second most valued metric after data citation would be derived from repository download data.

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[2]Ingwersen, P., and V. Chavan. "Indicators for the Data Usage Index (DUI): An Incentive for Publishing Primary Biodiversity Data Through Global Information Infrastructure. BMC Bioinformatics 12 (Suppl 15), S3. (2011). http://doi.org/10.1186/1471-2105-12-S15-S3

[3] Fear, K. M. "Measuring and anticipating the impact of data reuse." University of Michigan. (2013). http://deepblue.lib.umich.edu/handle/2027.42/102481

[4] Strasser, C., John Ernest Kratz, and Jennifer Lin "Make Data Count - Unit 1 Final Report." (2015). Figshare. http://dx.doi.org/10.6084/m9.figshare.1328291

3.4 Data Metrics Definitions

3.4.1 What is a Published Dataset?

In the context of dataset metrics, a published dataset is considered a managed collection of data that has been made available for access and/or download (http://www.w3.org/TR/vocab-dcat/#class-dataset). It has ideally been assigned a persistent identifier and is described by metadata: "...a dataset may be generated as part of some scientific investigation, whether tabulated from observations, generated by an instrument, obtained via analysis, created through a mashup, or enhanced or changed in some manner" (http://www.w3.org/TR/hcls-dataset). Datasets are not necessarily 'collections of numbers': different disciplines have different investigatory methodologies. In this case, a dataset might be a transcript of an interview, a set of digitized images or some other artefact of the research process. See Section 2, "Alternative Outputs in Scholarly Communications."

3.4.2 What is Data Citation?

Data citation is the practice of providing a formal, structured reference in a scholarly work to a dataset, realized as citation to the full bibliographic reference information of the dataset. By way of contrast is the issue of granular citation, e.g., the citation of some subset of a dataset, whether a data subcomponent or a particular value (http://www.codata.org/task-groups/data-citation-standards-and-practices).

In 2014, the Joint Declaration of Data Citation Principles was released by the Data Citation Synthesis Group within FORCE11 (https://www.force11.org/group/joint-declaration-data-citation-principles-final). These guiding principles emphasize the role of research data in scientific communication by enabling citation to facilitate credit and attribution for contributions to data generation, and support data reuse. While more and more organizations and individuals endorse this declaration, it lacks practical guidance for implementation.

In order to create guidance for those who wish to implement the Joint Declaration of Data Citation Principles, the Force11 Data Citation Implementation Group (https://www.force11.org/group/data-citation-implementation-group) was formed and is working on topics such as:

• machine-readable data citations in the JATS XML schema for journal articles

• a list of identifier schemes conformant to the Joint Declaration

• use cases of publishing workflows for data deposition, identifier validation, and citation

3.4.3 What is Data Usage?

Data usage refers to the act of accessing and downloading a published research dataset (https://rd-alliance.org/sites/default/files/case_statement/RDA_WDS_WG_Publishing_Bibliometrics.pdf). COUNTER is the standard for defining usage of networked electronic resources, including journals, databases, books, and reference works. A corresponding standard for datasets does not yet exist. Many aspects of the COUNTER Code of Practice could also be applied to research data, as was done in the Making Data Count project for about 150,000 research datasets (http://mdc.lagotto.io).

The COUNTER Code of Practice explicitly ignores data derived from non-human sources, whether pieces of software that harvest content automatically, or search-engine robots. As non-human agents become more prevalent in the reuse of scientific data, this aspect has to be considered for data usage statistics, an important step beyond the existing COUNTER Code of Practice. For example, a researcher could develop an application that automatically downloads a fresh copy of a dataset. It is important to note the value of this form of access and not to automatically discount it. Furthermore, as APIs become more commonplace, access to research datasets may become more fragmented and more frequent over time, and metrics should be developed to recognize these trends. The standard counters the issue of repeated, failed attempts at downloads by treating repeated download activities within a certain time frame as single events.

Another key difference in properties between research datasets and text documents such as journal articles is that data more frequently change over time. It is therefore important to specify the version of a dataset that led to a particular result. Datasets are also often made available in multiple parts or files, making it harder to aggregate usage statistics.

Strasser, Kratz, & Lin explained that many repositories were unable to report any data relating to download activity, and that the development and adoption of robust reporting tools and standards, including the ANSI/NISO standard SUSHI and NISO technical document SUSHI-lite (http://www.niso.org/workrooms/sushi/sushi_lite/), are needed for adoption.

3.4.4 What are altmetrics for data?

On the surface, altmetrics for data are conceptually and technically not really different from altmetrics for journal articles. Research data can accumulate similar metrics to other types of scholarly outputs (i.e., mentions of data in a blog post or tweets that share an article can be retrieved using the same mechanisms for both types of outputs).

There are a number of data-specific altmetrics that exist, as well. Output-specific altmetrics that can get at data reuse and experimentation (such as GitHub forks) and collaboration patterns (GitHub collaborators) already exist, and it's possible that newer data altmetrics may soon be realized (for example, a data dependency page rank akin to Impactstory's Depsy software dependency page rank, which could identify the extent to which research data is reused/remixed in other influential datasets and studies, or text-mining for direct links to datasets that appear in journal articles, as Depsy does for software).

3.4.5 What are persistent identifiers for data?

Identifiers play an important part in the development of metrics, whether they relate to an article (e.g., a Crossref DOI), a dataset (i.e., a DataCite DOI), or an individual (e.g., an ORCID).

We recommend that attention be paid to the question of identifying a specific subset or components of a dataset. This scenario is common, and is a particular challenge for data that are continuously growing (e.g., time series data) or otherwise dynamic. For example, both DataCite and Crossref have established methods for identifying components within the documents identified by a single DOI, for example data components within a single published data set. These should become interoperable (or ideally a single agreed standard) as the field matures. See Section 4, "Persistent Identifiers in Scholarly Communications."

3.5 Organizations Involved in Research Metrics

3.5.1 Method

The approach of Working Group B was to investigate existing best practices and standards that might exist in the area of unconventional research metrics. The working group therefore researched related organizations, inviting some to meetings of the working group or seeking other representation.

3.5.2 Consulted bodies

The organizations involved in the consultation process were:

- **COUNTER (http://www.projectcounter.org/).** Formed in 2002 to enable standards in reporting journals and database downloads, COUNTER is a UK-based international organization. It is supported by vendors, intermediates, and librarians.

- **RDA (http://www.rd-alliance.org).** The Research Data Alliance exists to build the social and technical bridges needed to facilitate the open sharing of data.
- **CASRAI (http://casrai.org).** The Consortia Advancing Standards in Research Administration Information is an international organization dedicated to improving the flow of information among research stakeholders.
- **Jisc (http://www.jisc.ac.uk).** Jisc is a UK-based organization that provides infrastructure and other support to UK higher-education establishments. Jisc continues to be active in the area of data repositories and data sharing more generally.
- **DataCite (http://www.datacite.org).** DataCite manages DOIs and metadata, with a focus on research data.
- **BioCADDIE (http://biocaddie.org).** BioCADDIE is a project that aims to build a data-discovery index of research data to enhance the discovery and use of such data.
- **California Digital Libraries (http://www.cdlib.org), PLOS (https://www.plos.org),** and **DataONE (https://www.dataone.org),** partners in Making Data Count (http://mdc.lagotto.io/)

3.6 Findings

The issues surrounding data citation, and the recommendations for how to deal with it going forward, have been well described in the *Joint Declaration of Data Citation Principles*, and in the implementation recommendations by Starr et al[5]. Our position is to recommend these developing standards and to encourage the promotion of data citation and the citability of research datasets.

The COUNTER Code of Practice provides a set of well-recognized recommendations to count the download of research articles. COUNTER recommendations include such parameters as excluding non-human downloads (recognized by the header information), and eliminating fast repetition of downloads from the same machine. Putting forward such parameters is done in order to reduce the number of downloads counted that originate from automated web crawlers, or from attempts to artificially increase the number of downloads. However, we recognize that in the case of data downloads, there will be a number of legitimate use-cases in which machines will be downloading datasets; for example, via the CURL command-line utility, or via file-handling wrappers. Furthermore, it may be useful to make a distinction between useful web crawlers, such as products that index and search research datasets, and the ordinary web-link-following crawlers.

The RDA Publishing Data Bibliometrics Working Group is part of the RDA/WDS Publishing Data Interest Group. It liaises with other RDA working groups, such as the Publishing Data Services Working Group, which founded the DLISERVICE data-literature interlinking service (http://dliservice.research-infrastructures.eu/). Although this group has not published any recommendations or standards, Callaghan, Carpenter, & Kratz[6] published the results of a survey conducted in 2014 that indicated that lack of standards in counting downloads was a key obstacle in the use of the data.

[5] Starr J. et al. Achieving Human and Machine Accessibility of Cited Data in Scholarly Publications. PeerJ Computer Science 1 (1). (2015). http://doi.org/10.7717/peerj-cs.1

[6] Callaghan, S, T. Carpenter, and J. E. Kratz (2015). "Walk Softly and Carry a Large Carrot: How To Give Credit for Academic Work." In: FORCE2015, 12-13 January 2015, Oxford, UK. http://cedadocs.badc.rl.ac.uk/1125/1/FORCE2015_poster_final.pdf

CASRAI has a related Data Level Metrics working group (http://ref.casrai.org/Research_Dataset-Level_Metrics). After discussions with the NISO working group, it was decided that the two groups would maintain a number of bilateral relationships, and that CASRAI would focus on data quality indicators, rather than data usage and sharing.

Jisc, as a component of its "Research at Risk" activity to support good research data management, is piloting an implementation of the existing IRUS-UK service (http://www.irus.mimas.ac.uk/) that will report on, at a file level, downloads of material in institutional and subject area research data repositories. IRUS (and the experimental IRUSdataUK, http://rdmetrics.jiscinvolve.org/wp/2016/01/11/a-note-about-irusdatauk/) is an implementation of the COUNTER standard, which can be plugged into nearly all common repository software.

BioCADDIE has an interest in research data metrics. Rather than start a new discussion, co-chairs of the relevant BioCADDIE workgroup have agreed to participate with the existing projects, namely NISO, CASRAI, THOR, and Making Data Count.

Strasser, Kratz, & Lin (2015) surveyed 247 interested parties. They concluded that although citations are the key measure of data impact, few data repositories have implemented relevant standards and working practices; however, most do count data downloads. The authors reported that while data citation is regarded by researchers as the prime way of recognizing data use, consistency and adoption have been weak spots. It is these areas that the FORCE11 declarations hope to address. Despite interest in alternative (social sharing) metrics for publications, there is little interest in this area for data at present. However, the authors report that download counts are considered valuable, and that these are used by dataset creators who collect them.

Having had discussions with people involved in hosting very large streaming data, members of the NISO working group wish to recognize that data metrics of the sort described in this document refer to discrete objects of published research datasets, rather than unprocessed streaming data of the type created, managed, and served by large data centers.

3.7 Recommendations

Researchers, funders, institutions, data repositories, and publishers increasingly expect research data to be made publicly available in dedicated data repositories, and to have access to tools and platforms that support them in understanding the ways in which their data is being used. With the significant and global interest in research data and research data reuse has come the need to more formally assess this data reuse, and to develop best practices for research data metrics.

Metrics for research data must be seen in the bigger context of bibliometrics for other research outputs. Many of same principles that apply to metrics for research articles, books, or book chapters can also be applied to research data.

These recommendations, therefore, are primarily addressed to institutions and repository managers, international bodies working with research data, and funders.

3.7.1 Access to Research Data Metrics

Just as it is now generally required that research data be made available by default (https://www.force11.org/group/joint-declaration-data-citation-principles-final), data about the use of this data should be created and maintained in such as way that it can be made available as widely as possible.

3.7.2 Data Citation

The *Joint Declaration of Data Citation Principles* (JDDCP, https://www.force11.org/group/joint-declaration-data-citation-principles-final) provides important principles that should be followed for data citation. Work on implementing these data citation principles is ongoing, e.g., in the FORCE11 Data Citation Implementation Pilot (DCIP, https://www.force11.org/group/data-citation-implementation-pilot-dcip), the RDA/WDS Publishing Data Interest Group, and the COPDESS project (http://www.copdess.org/). The following general recommendations are common to these activities.

3.7.3 Machine-actionable Persistent Identifiers

Data citation requires "a persistent method for identification that is machine actionable, globally unique, and widely used by a community"[7]. In some communities, such as the life sciences, it is common to use identifiers local to a particular system that are not machine actionable across systems. Work is ongoing—for example, in the DCIP project—to provide globally unique, machine-actionable identifiers to these communities, e.g., via the resolving services identifiers.org (http://identifiers.org) or n2t.net (http://n2t.net).

3.7.4 Required Metadata

The minimal metadata required for a data citation (e.g., persistent identifier, authors, title, publisher, publication date) should be made available by data repositories. This should be done via the landing page for the dataset in human and machine-readable format, e.g., using Dublin Core and PRISM HTML meta tags similar to those used when observing best practices for journal articles (https://scholar.google.de/intl/en/scholar/inclusion.html#indexing). The required metadata should also be registered with the persistent identifier when the persistent identifier supports metadata, e.g., when using a DOI.

3.7.5 Landing Pages

Following the recommendations by Starr et al, the identifier included in a citation should point to a landing page or set of pages rather than to the data itself. The landing page should persist even if the data is no longer accessible.

3.7.6 Reference Lists

Data citations should be included in the metadata of the citing resource. For many textual resources, such as journal articles and book chapters, a natural place for these data citations would be the reference list. The current practice of citing data in the text without additional metadata limits adoption of data citation because a) these data citations might not be available where access to the full text is restricted, and b) they can be difficult to find in the text when using automated text mining.

3.7.7 Research Data Usage Statistics

Research data sharing platforms, including data repositories, should work on standards and best practices for collecting and reporting standard usage statistics for research data. This work should be based on the COUNTER code of practice and on the lessons learned with usage statistics for journal

[7] https://www.force11.org/group/joint-declaration-data-citation-principles-final, principle 4 (unique identification)

articles, but should take into account the special considerations that apply to research data. The Research Data Alliance (RDA), COUNTER, and NISO are important organizations that should also be involved in this standardization work.

Formulations should recognize the rise of non-human download agents used in research, and report on activity appropriately. We suggest that there be two formulations: one examining only “human” downloads, and another including downloads identified as being from genuinely research-focused non-human agents. As currently happens, downloads from known nonconstructive and vexatious agents should be excluded from statistical reports.

By default, repositories should use standard persistent identifiers, and record download counts, header information, and deposit and creation times. These parameters are required to support COUNTER-compliance, and represent what should become standard practice in research data management. Consistent with the recommendations for data citation, machine-actionable persistent identifiers and landing pages should be used for research data usage statistics.

As research funders begin to standardize approaches to research data management support, grants and other assistance mechanisms should be made available to support data repositories in implementing standards for research data usage statistics.

3.7.8 Altmetrics for Datasets

There currently seems to be a lack of interest in altmetrics for data in the community. This matches trends we see for altmetrics for journal articles, as well[i]. However, there may be those in the community that do find altmetrics data important to their work (as we have seen for altmetrics for other types of scholarly outputs).

Studies of altmetrics for data have been limited. We encourage more investigation into existing altmetrics for data and for as-yet-undetermined metrics, as well. One altmetrics provider, Altmetric LLP, has offered its data for analysis—approximately 0.3 percent (~15,500) of the > 6 million outputs Altmetric tracks are datasets from the figshare, Dryad, Zenodo, and Pangea data repositories. Analysis of data from other providers that track data-specific metrics like those mentioned above (Section 3.4) could yield further insights.

Section 4:
Persistent Identifiers in Scholarly Communications

4.1 Background and Context

The use of Persistent Identifiers has increased as scholarly communications have become increasingly digital. In particular, use of the Digital Object Identifier (DOI), which began in 2000, has become pervasive when identifying scholarly articles, and latterly research data and alternative research products. In common with other persistent identifiers, the DOI Foundation obliges certain metadata and linking technologies to be adopted by its users. The consequence of using semantic and other standard approaches is that open infrastructures can be built to support interoperability and to support open science. For example, the ORCID organization, DataCite, and Crossref are able to map documents, data, and researchers using DOIs and ORCIDs.

Recently there has been an increase in the number of kinds of persistent identifiers used in scholarly communications. Persistent identifiers enable linking of persons, organizations, and scholarly outputs to each other – an essential component of altmetrics. By listing and detailing them in this document, we hope to encourage efforts to support open science and interoperability, and to measure, evaluate, and report on the effectiveness of research infrastructure and communication. Our ultimate goal is to promote and facilitate the broad use of persistent identifiers whenever possible.

The focus for the NISO Persistent Identifiers and Alternative Outputs Working Group included investigation of alternative research outputs and application of persistent identifiers in the scholarly environment to clearly identify research outputs and their relationships. The composition of the Persistent Identifiers and Alternative Outputs Working Group was developed to represent a balance of parties who are interested in unconventional research outputs and identifiers, with just under half of the 33 members coming from academic institutions and libraries. Publishers and other organizations in the scholarly ecosystem make up the majority of the rest of the group's membership. The organizations represented are drawn from bodies that have an interest in research output metrics.

4.2 Persistent Identifiers in Scholarly Communications Document

The persistent identifiers in Scholarly Communications Document (see https://sites.google.com/site/nisopersistentids/) is an environmental scan of common persistent identifiers that are used across a variety of scholarly domains to identify research outputs of any known type. Persistent identifiers may be applied to content at multiple levels of granularity, from links to a subset of a dataset to links to aggregated content. The purpose of this document is to raise awareness of the scope and complexity of persistent identifier use across systems, in the hopes of promoting and facilitating the use of persistent identifiers.

The scholarly environment is growing and evolving at a breakneck pace. Work that is accomplished with this attempt to identify and characterize ongoing efforts regarding persistent identifiers will become obsolete almost as soon as it is published. For these reasons, and to promote ongoing engagement with the broader scholarly community, this document is available online at https://sites.google.com/site/nisopersistentids/. The document provides a sorted set of known persistent identifiers, with a source, links to schema information or project site, domain relevance, and additional notes about the identifier, where available. The domains vary to include computing, general, government, life sciences, locations, mathematics, media, objects, persons, physical sciences, publishing, and standards. Selection criteria for this initial work included commonly used persistent identifiers in scholarship and other persistent identifiers of emerging, historical, or established potential value.

We invite public comment and input to the document to support an ongoing discussion on the topic of persistent identifiers leveraged as part of modern research and scholarly work.

4.3 Implications for Future Research

Future work in this area may include further characterization of the persistent identifiers for attributes such as availability of an API (application programming interface) and availability of persistent identifiers as RDF (Resource Description Framework) or other data formats. A better examination of the relative amounts of data available for each identifier is also needed. Other areas of work could include assessment of the extent of unconventional research outputs types that are not yet managed with persistent identifiers, which are a critical component of enabling long-term management of access and relationships. Finally, there is an opportunity to help support a meaningful conversation about persistent identifiers and the use of URIs (Uniform Resource Identifiers). Ultimately, work must focus on these and other key areas to support the value of persistent identifiers to support interoperability and data exchange.

Section 5: Altmetrics Data Quality Code of Conduct

5.1 Purpose and Scope

The Code of Conduct aims to improve the quality of altmetric data by increasing the transparency of data provision and aggregation as well as ensuring replicability and accuracy of online events used to generate altmetrics. It is not concerned with the meaning, validity, or interpretation of indicators derived from that data. Altmetrics are "indicators...derived from activity and engagement among diverse stakeholders and scholarly outputs in the research ecosystem, including the public sphere," as defined in Section 1 of this document.

5.2 Data Quality Code of Conduct Terminology

Term	Definition
altmetric data providers	Platforms that function as sources of online *events* used as altmetrics (e.g., Twitter, Mendeley, Facebook, F1000Prime, Github, SlideShare, Figshare). The working group is aware that not all altmetric data providers—Twitter and Facebook, for example—are part of the scholarly communication community.
altmetric data aggregators	Tools and platforms that aggregate and offer online *events* as well as derived *metrics* from altmetric data providers (e.g., Altmetric.com, Plum Analytics, PLOS ALM, ImpactStory, Crossref).
transparency	The degree to which information and details about the provided data are clear, well-documented, and open to all users (human and machine) for verification
replicability	The degree to which a set of data is consistent across providers and aggregators and over time
accuracy	The degree to which the collected data reflects the material it claims to describe

5.3 Recommendations

5.3.1 Transparency

Altmetric data providers are encouraged, and altmetric data aggregators are expected to be **transparent** by offering information about:

- how data are generated, collected, and curated (T1);
- how data are aggregated, and derived data generated (T2);

- when and how often data are updated (T3);
- how data can be accessed (T4);
- how data quality is monitored (T5).

5.3.2 Replicability

Altmetric data providers are encouraged, and altmetric data aggregators are expected to offer **replicable** data by ensuring that:

- the provided data is generated using the same methods over time (R1);
- changes in methods and their effects are documented (R2);
- changes in the data following corrections of errors are documented (R3);
- data provided to different users at the same time is identical or, if not, differences in access provided to different user groups are documented (R4);
- information is provided on whether and how data can be independently verified (R5).

5.3.3 Accuracy

Altmetric data providers are encouraged, and altmetric data aggregators are expected to offer **accurate** data by ensuring that:

- the data represents what it purports to reflect (A1);
- known errors are identified and corrected (A2);
- any limitations of the provided data are communicated (A3).

5.4 Annual Report

By following the Code of Conduct **altmetric data providers** and **altmetric data aggregators** agree to provide a publicly available annual report documenting in detail how they adhere to the recommendations above. The report should follow the standard format provided in the self-reporting table (see Appendix A) which complements the recommendations of the Code of Conduct and includes sample reports (see Appendix B) for a selection of altmetric data providers and aggregators.

Appendix A:
NISO Altmetrics Working Group C "Data Quality"
Code of Conduct Self-Reporting Table

Item	Description	Supports CoC Recommendation	Aggregator / Provider Submission	Last update of self-reporting table
#1	List all available data and metrics (providers and aggregators) and altmetric data providers from which data are collected (aggregators).	T1	*To be filled out by data aggregator / provider*	
#2	Provide a clear definition of each metric.	A1	*To be filled out by data aggregator / provider*	
#3	Describe the method(s) by which data are generated or collected and how data are maintained over time.	T1, T2, R1	*To be filled out by data aggregator / provider*	
#4	Describe all known limitations of the data.	A3	*To be filled out by data aggregator / provider*	

#5	Provide a documented audit trail of how and when data generation and collection methods change over time and list all known effects of these changes. Documentation should note whether changes were applied historically or only from change date forward.	R1, R2, R3	*To be filled out by data aggregator / provider*	
#6	Describe how data are aggregated.	T2	*To be filled out by data aggregator / provider*	
#7	Detail how often data are updated.	T3	*To be filled out by data aggregator / provider*	
#8	Describe how data can be accessed.	T4	*To be filled out by data aggregator / provider*	
#9	Confirm that data provided to different data aggregators and users at the same time are identical and, if not, how and why they differ.	R4	*To be filled out by data aggregator / provider*	
#10	Confirm that all retrieval methods lead to the same data and, if not, how and why they differ.	R4	*To be filled out by data aggregator / provider*	
#11	Describe the data-quality monitoring process.	T5, A2	*To be filled out by data aggregator / provider*	

#12	Provide a process by which data can be independently verified.	R5	*To be filled out by data aggregator*	
#13	Provide a process for reporting and correcting data or metrics that are suspected to be inaccurate.	A2	*To be filled out by data aggregator / provider*	

Appendix B: NISO Altmetrics Working Group C "Data Quality" Code of Conduct Self-Reporting Table: Samples[*]

(This appendix is not part of the ANSI/NISO RP-25-2016 *Altmetrics Data Quality Code of Conduct*. It is included for information only. Note also that the following data were collected by the NISO Altmetrics Working Group C in collaboration with some altmetric aggregators for the purposes of this Recommended Practice.)

Example for data aggregator: Altmetric.com

Item	Description	Supports CoC Recommendation	**Aggregator / Provider Submission***	**Last update of self-reporting table****[**]
#1	List all available data and metrics (providers and aggregators) and altmetric data providers from which data are collected (aggregators).	T1	Altmetric collects data from: Twitter, Facebook, Google+, policy documents, mainstream media, blogs, Mendeley, CiteULike, PubPeer, Publons, Reddit, Wikipedia, sites running Stack Exchange (Q&A), reviews on F1000, and YouTube. More details can be found on our Support page: http://bit.ly/1SXDl4	2016/02/05

[*] No field should be left blank. If a provider cannot submit the requested information, each element that cannot be provided should be stated.

[**] Annual updates of the self report need to be provided publicly by altmetric data providers and aggregators that claim CoC compliance. Reports from previous years should be archived to document CoC compliance over time.

#2	Provide a clear definition of each metric.	A1	The Altmetric score of attention is a weighted algorithm providing an indicator of the amount of attention a particular piece of research output has received. Full details on how the score is calculated can be found here: http://www.altmetric.com/blog/scoreanddonut/ Altmetric tools also provide the raw mention counts by source, e.g., the number of posts we have seen about a specific research output on Google+. Raw counts can be viewed in the application, e.g., in the Altmetric Details Page, or exported for further analyses.	2016/02/05
#3	Describe the method(s) by which data are generated or collected and how data are maintained over time.	T1, T2, R1	Data are collected via a range of methods, largely via data provider APIs, third-party provider APIs, text mining and RSS feeds. More information on collection methods by source can be found on our Support page.	2016/02/05
#4	Describe all known limitations of the data.	A3	Altmetric started tracking attention to research across sources in January 2012 and the data collected on articles published before this date is likely to be incomplete. In order to track attention to an output it must have a unique identifier that is supported in our system, e.g., Digital Object Identifier (DOI), arXiv ID, or International Standard Book Number (ISBN), and be hyperlinked or mentioned by journal, author, and date in order to be collected by our text-mining modules operating across news and policy sources. Links to original posts may break, or posts be deleted. We track public pages only, e.g., public Facebook posts, and cannot access private accounts.	2016/02/05

#5	Provide a documented audit trail of how and when data generation and collection methods change over time and list all known effects of these changes. Documentation should note whether changes were applied historically or only from change date forward.	R1, R2, R3	Altmetric does not have an audit trail before January 2016.	2016/02/05
#6	Describe how data are aggregated.	T2	Online events about research outputs are aggregated and mapped by their external persistent identifiers, e.g., DOI, Handle, PubMed Identifier (PMID), arXiv ID.	2016/02/05
#7	Detail how often data are updated.	T3	Update frequency differs across data sources—from real-time to daily. More details on update frequency by source can be found on our Support page: http://bit.ly/1SXDI4j	2016/02/05
#8	Describe how data can be accessed.	T4	Altmetric provides access to the data via end-user interfaces, the Altmetric Application Programming Interface (API), or by providing a snapshot of the data set made available upon request to organizations or individuals for research purposes. Our API documentation is open and available here: http://api.altmetric.com	2016/02/05
#9	Confirm that data provided to different data aggregators and users at the same time are identical and, if not, how	R4	All Altmetric applications are based on the same database. Users access the same data across each tool, except where data are cached and restricted according to access level. Access level varies across products. Explorer for Publishers,	2016/02/05

	and why they differ.		Explorer for Institutions, Explorer for Funders, Altmetric Badges, and the Altmetric Commercial API require a subscription to access all data. The Altmetric Bookmarklet, Institutional Repository Badges, Explorer for Academic Librarians, and the Researcher API are free tools that provide access to all mentions. More details can be found on our Products page: http://www.altmetric.com/products/. The article report pages seen within the Altmetric Explorer product or when the Altmetric Badges are clicked on are cached for 60 minutes by the content delivery network we use. Therefore, it is possible that a change to an output that appears in the API results immediately will not be reflected in the relevant article report page for up to an hour. The article report pages seen within the Altmetric Explorer product or when the Altmetric Badges are clicked on are cached for 60 minutes by the content delivery network we use. Therefore, it is possible that a change to an output that appears in the API results immediately will not be reflected in the relevant article report page for up to an hour.	
#10	Confirm that all retrieval methods lead to the same data and, if not, how and why they differ.	R4	Different retrieval methods will lead to the same data as all Altmetric applications use the same underlying database and API. However, the article report pages seen within the Altmetric Explorer product or when the Altmetric Badges are clicked on are cached for 60 minutes by the content delivery network we use (Fastly). Therefore, it is possible that a change to an output that appears in the API results immediately will not be reflected in the relevant article-report page for up to an hour.	2016/02/05

#11	Describe the data-quality monitoring process.	T5, A2	Data quality is monitored in a range of ways: by manually curating sources; monitoring potential gaming and spammy posts; setting thresholds to automatically flag suspicious activity, such as rate of change in attention for an output; creating suspicious-person profiles; and manually monitoring Altmetric staff's alerts and reported issues. Regular data clean-up tasks are also run, e.g., cross-referring data accuracy against external sources such as Crossref.	2016/02/05
#12	Provide a process by which data can be independently verified (aggregators only).	R5	See item #8—the tools and services provided by Altmetric use the API documented at http://api.altmetric.com	2016/02/05
#13	Provide a process for reporting and correcting data or metrics that are suspected to be inaccurate.	A2	Suspected inaccurate metrics or data can be reported to support@altmetric.com and via our Support portal: help.altmetric.com. Missed mentions can be reported via an online form: www.surveymonkey.com/s/missedmentions. All Altmetric Details Pages include a "What is this page?" message to provide opportunities for reporting data errors and linking to the Missed Mentions form. The page also provides an introduction to Altmetric data.	2016/02/05

NISO Altmetrics Working Group C "Data Quality" – Code of Conduct Self-Reporting Table

Example for data provider: Crossref, Crossref Event Data (CED)

Crossref CED is a new service by Crossref that will launch during 2016. Openness is at the core of the design of CED. Crossref is working towards abiding by the Altmetrics Data Quality Code of Conduct as it moves toward the launch of CED.

Item	Description	Supports CoC Recommendation	Aggregator / Provider Submission*	Last update of self-reporting table**
#1	List all available data and metrics (providers and aggregators) and altmetric data providers from which data are collected (aggregators).	T1	CED is a platform for collecting event data. The data are gathered through a combination of actively collecting data from non-scholarly sources and allowing scholarly sources to send data. It focuses on events ("these things happened") not aggregations ("this many things happened") or metrics ("you got this score"). At launch Crossref CED will include: • **Links from Crossref DOIs to DataCite DOIs**. These are dataset citations made by publishers that indicate when the metadata for an article cites a dataset via Crossref. • **Links from DataCite DOIs to Crossref DOIs**. These are article citations made by dataset publishers that indicate in the metadata for a dataset that the dataset is linked to a Crossref DOI, via DataCite. • **Twitter DOI mentions**. These are tweets that mention an article or dataset by its DOI, or via the landing page of the DOI. It applies to DOIs that belong to Crossref and DataCite. The data are supplied by Twitter and filtered by Crossref CED.	2016/02/05

			• **Wikipedia DOI citations and uncitations**. These are edits to Wikipedia pages that mention a DOI directly, or edits that remove such mentions. The data are supplied by Wikipedia and filtered by Crossref CED. • **Data supplied by other providers**. We allow data providers to supply us with individual events concerning DOIs. We are working with a prominent player in the scholarly space. Every event, such as "this DOI was annotated" is recorded. The data are sent directly from the provider. • **Facebook**. Number of "shares," "likes" and "comments" for a given DOI, as retrieved from the Facebook API.	
#2	Provide a clear definition of each metric.	A1	Crossref CED reports raw events, not metrics. The following events are provided: • **Links from Crossref DOIs to DataCite DOIs**. Crossref is the central linking hub for scholarly communications. Publishers deposit metadata about articles as they are published. This includes links to datasets via DataCite. • **Links from DataCite DOIs to Crossref DOIs**. Researchers deposit scholarly research objects for citation to DataCite. Researchers deposit datasets and provide links to scholarly works via Crossref DOIs. • **Twitter DOI mentions**. People discuss scholarly works via their DOIs, or the landing pages to which those DOIs resolve. Crossref works with the Twitter data source, filtering Crossref and DataCite DOIs and corresponding landing pages. • **Wikipedia DOI citations and uncitations**. Wikipedia pages are edited on a constant basis. A page can reference a DOI, and an edit to a page can introduce or remove a link to a DOI. Crossref tracks when these events happen and records when a DOI is added or	2016/02/05

			removed from a page, the DOI, and the page and revision numbers. • **Data supplied by other providers**. Providers are able to push events, such as when a DOI is shared or mentioned, into the CED service. The content of the event is dependent on the type of source. CED will make the event available verbatim. Events are supplied by the party that generated them. • **Facebook**. Facebook Graph API allows CED to query for every DOI it knows about and record how many times a DOI was shared, liked, and commented on. Each time this data are collected is treated as an event.	
#3	Describe the method(s) by which data are generated or collected and how data are maintained over time.	T1, T2, R1	• **Links from Crossref DOIs to DataCite DOIs**. CrossRef identifies deposits and updates CED when it sees a DataCite DOI cited. This will happen in bulk for historical data, and will then be completed live as new deposits are made. • **Links from DataCite DOIs to Crossref DOIs**. DataCite identifies deposits and updates CED when it sees a Crossref DOI cited. This will happen in bulk for historical data, and then will be done live as new deposits are made. • **Twitter DOI mentions**. Crossref CED subscribes to the Twitter firehose, filtering it by Crossref and DataCite DOIs and those domains that DOIs resolve to. It stores all tweets that mention DOIs. For tweets that mention article or dataset landing pages, CED will attempt to identify the corresponding DOI and record that link (including both the DOI and the landing page URL). Not all landing pages URLs can be mapped to DOIs, but if a new technique enables a previously unknown mapping for a historical tweet, this event will be raised. The firehose is a live stream.	2016/02/05

			• **Wikipedia DOI citations and uncitations**. Crossref CED subscribes to the Wikipedia live stream of edits. For every edit that is made to any Wikipedia article, CED will analyze the content of the edit and look for DOIs having been added or removed. An event will be recorded for either the adding or removal of a DOI in a Wikipedia page. The edit stream is live and produces a live stream of events. • **Data provided by other providers**. Crossref CED provides a "Push API" that enables data sources to push data into CED. Providers can push data in batches or live. This is a generic capability, but allows for significant players in the scholarly space to publish DOI event data. • **Facebook**: The Facebook API is queried for every DOI that belongs to Crossref or DataCite. The results are stored directly. The Facebook API is queried periodically. There are no guarantees about how often the Facebook API is queried as this depends on practical issues of scalability.	
#4	Describe all known limitations of the data.	A3	• **Links from Crossref DOIs to DataCite DOIs**. Publishers must provide data. Crossref has around 5,000 publisher members and there are some variabilities among them. • **Links from DataCite DOIs to Crossref DOIs**. Researchers must provide data to DataCite. • **Twitter DOI mentions**. All DOIs in tweets can be reliably identified. In the case of landing pages, Crossref CED will make a best effort to resolve the landing pages, but there is no 100 percent reliable way to do this. • **Wikipedia DOI citations and uncitations**. The Wikipedia live stream or supporting infrastructure may	2016/02/05

			become unavailable. If this happens, those events will be missed. • **Data provided by other providers**. The content of pushed data are the responsibility of those pushing the data. However, as they are the source, the data they do push can be considered to be canonical and of the best available quality. • **Facebook**. As Crossref CED will be querying the Facebook API for a large number of DOIs, the period between updates is entirely dependent on practical scaling issues. CED may prioritize fetching data for DOIs that are more likely to have activity.	
#5	Provide a documented audit trail of how and when data generation and collection methods change over time and list all known effects of these changes. Documentation should note whether changes were applied historically or only from change date forward.	R1, R2, R3	Events data are passed directly through. We provide no metrics. All events have a timestamps for when they occurred and when they were generated or collected. Thus the infrastructure used to generate and collect events can be matched to the timestamp. The Lagotto software is open source, so date stamps can be correlated to the version of the software that was running.	2016/02/05
#6	Describe how data are aggregated.	T2	Events are stored individually and returned individually. CED will collect data and make it available without aggregation.	2016/02/05
#7	Detail how often data are updated.	T3	CED provides an API to allow users to get data at any point. Data will be made available on the API as soon as possible after it is inserted into CED.	2016/02/05

			• **Links from Crossref DOIs to DataCite DOIs**. Every time DOI metadata is deposited with Crossref the related events occur and are pushed into CED, effectively creating a live stream. • **Links from DataCite DOIs to Crossref DOIs**. Every time DOI metadata is deposited with DataCite the related events occur and are pushed into CED, effectively creating a live stream. • **Twitter DOI mentions**. A live stream. • **Wikipedia DOI citations and uncitations**. A live stream. • **Data from other providers**. Depending upon the providers, these can be received as a live stream or sent in batches. • **Facebook**. The update of Facebook events is yet to be determined.	
#8	Describe how data can be accessed.	T4	All data will be freely available via the CED API. The raw data will be the primary way of interacting with CED. For a fee, we will also provide an SLA (service-level agreement) that will guarantee consistency of service (guaranteed response times to API calls). The data will be identical to the free version, however.	2016/02/05
#9	Confirm that data provided to different data aggregators and users at the same time are identical and, if not, how and why they differ.	R4	CED provides an API, which will allow users to make queries against DOIs to retrieve events. CED also provides an SLA version of the API. This will have identical data, but we make guarantees of response times. There will be a single API for all data, which is open. Using the SLA version of the API provides identical data.	2016/02/05

#10	Confirm that all retrieval methods lead to the same data and, if not, how and why they differ.	R4	All retrieval methods produce the same data. There is a single API, although there are service level agreements which guarantee response times.	2016/02/05
#11	Describe the data-quality monitoring process.	T5, A2	The main failure mode will be service interruptions, meaning data sources becoming unavailable. These will be monitored per source to ensure that there is a constant stream of data. For CED, quality means consistency not, e.g., detection of gaming.	2016/02/05
#12	Provide a process by which data can be independently verified (aggregators only).	R5	All data will be freely available. The source code of the software used to generate the data will also be freely available.	2016/02/05
#13	Provide a process for reporting and correcting data or metrics that are suspected to be inaccurate.	A2	Crossref support will be able to handle requests. We can attempt to reprocess raw data to re-generate events. We can back-fill missing events with appropriate date-stamps. As we are not aggregating events into metrics or scores, we will not provide scores which might later need adjustment.	2016/02/05

NISO Altmetrics Working Group C "Data Quality" – Code of Conduct Self-Reporting Table

Example for data aggregator: PLOS (Public Library of Science) Article Level Metrics (ALM)

Item	Description	Supports CoC Recommendation	Aggregator / Provider Submission*	Last update of self-reporting table**
#1	List all available data and metrics (providers and aggregators) and altmetric data providers from which data are collected (aggregators).	T1	PLOS collects metrics data from the following data providers: • **Citations**: Web of Science, Scopus, Crossref, PubMed, Europe PMC, DataCite • **Altmetrics**: Twitter, Facebook, Reddit, Mendeley, CiteULike, F1000Prime, ScienceSeeker, ResearchBlogging, Wordpress.com, Wikipedia, ORCID, and PLOS Comments • **Usage Stats**: PLOS, PubMed Central, Figshare	2016/02/05
#2	Provide a clear definition of each metric.	A1	• **Web of Science**: Citation counts from the Web of Science database • **Scopus**: Citation counts from the Scopus database • **Crossref**: Citation counts from the Crossref citedBy service for members • **PubMed**: Citation counts from full-text articles in PubMed Central • **Europe PMC**: Citation counts from full text articles in PubMed Central • **DataCite**: Number of references as relatedIdentifier in DataCite metadata	2016/02/05

			• **Twitter**: Number of tweets containing the DOI or journal-landing-page URL of the article • **Facebook**: Number of shares, likes, and comments for the journal-landing-page URL for the article, including private activity • **Reddit**: Reddit score and number of comments associated with the DOI or journal-landing-page URL for the article • **Mendeley**: Number of individual-user and group-readership counts • **CiteULike**: Number of bookmarks • **F1000Prime**: F1000 score and article classification • **ScienceSeeker**: Number of blog posts • **ResearchBlogging**: Number of blog posts • **Wordpress.com**: Number of blog posts • **Wikipedia**: Number of Wikipedia pages in 20 most popular Wikipedia sites worldwide, subdivided by language • **ORCID**: Number of ORCID records • **PLOS comments**: Number of comments on the PLOS article page • **PLOS Usage stats**: COUNTER usage statistics for HTML page views and PDF downloads from the PLOS website • **PubMed Central Usage** : Usage statistics for HTML abstract, full-text page views, and PDF downloads from PubMed Central • **Figshare**: Usage statistics for PLOS supplementary information hosted by Figshare	
#3	Describe the method(s) by which data are generated or collected and how data are	T1, T2, R1	Data are collected via public or private APIs. For F1000Prime and PubMed Central, usage data are downloaded as bulk files on a weekly or monthly basis,	2016/02/05

	maintained over time.		respectively.	
#4	Describe all known limitations of the data.	A3	The PLOS ALM service was started in 2009, with data providers added over time. No data for Twitter are available before the service launched in June 2012 because of limitations of the Twitter public APIs in providing historic data. For some services (e.g., Web of Science, Scopus, Mendeley, Facebook) only counts are available.	2016/02/05
#5	Provide a documented audit trail of how and when data generation and collection methods change over time and list all known effects of these changes. Documentation should note whether changes were applied historically or only from change date forward.	R1, R2, R3	No audit trail is available for PLOS ALM data. Changes in the open-source software that runs ALM, which can potentially affect how data are collected, are documented at https://github.com/lagotto/lagotto/releases.	2016/02/05
#6	Describe how data are aggregated.	T2	Data are aggregated by persistent identifier (DOI and PMID), and by month and day for the first 30 days after publication.	2016/02/05
#7	Detail how often data are updated.	T3	PLOS usage statistics are collected daily, PubMed Central usage statistics are collected monthly, and F1000Prime data are collected weekly. Twitter data are collected every six hours the first week after publication. All other data are collected based on article age, with daily data collection during the first month after publication, followed by weekly data collection during the first year after publication, and monthly after the first year.	2016/02/05

#8	Describe how data can be accessed.	T4	Data are made available via open API (http://alm.plos.org/api, no registration), in the metrics tab available for every PLOS article, via ALM Reports (http://almreports.plos.org), and as CSV file downloadable monthly via the Zenodo data repository (e.g., http://doi.org/10.5281/ZENODO.44558 from January 2016 onwards).	2016/02/05
#9	Confirm that data provided to different data aggregators and users at the same time are identical and, if not, how and why they differ.	R4	Data provided to different aggregators and users is identical. The only exception is Web of Science data, which are only available to PLOS services because of license restrictions.	2016/02/05
#10	Confirm that all retrieval methods lead to the same data and, if not, how and why they differ.	R4	Data provided via different retrieval methods is identical. The only exception is Web of Science data, which are not available via API and monthly CSV file because of license restrictions.	2016/02/05
#11	Describe the data-quality monitoring process.	T5, A2	Data quality of newly collected data is monitored via an automated process that runs every 24 hours and looks for outliers (unusual spikes in activity, etc.). Data quality is also monitored manually by PLOS staff, taking into account input from external users.	2016/02/05

#12	Provide a process by which data can be independently verified (aggregators only).	R5	The PLOS ALM service runs using open-source software (https://github.com/lagotto/lagotto), which can be installed to collect data and compare them to the PLOS data. Data can also be independently verified by obtaining them directly from data providers (e.g., Mendeley, Facebook, Wikipedia, etc.).	2016/02/05
#13	Provide a process for reporting and correcting data or metrics that are suspected to be inaccurate.	A2	Data or metrics that are suspected to be inaccurate can be reported to PLOS staff via a feedback form at (http://www.plosone.org/feedback/new).	2016/02/05

NISO Altmetrics Working Group C "Data Quality" – Code of Conduct Self-Reporting Table

Example for data aggregator: Facebook

Item	Description	Supports CoC Recommendation	Aggregator / Provider Submission*	Last update of self-reporting table**
#1	List all available data and metrics (providers and aggregators) and altmetric data providers from which data are collected (aggregators).	T1	Facebook provides different online-event counts for a specific URL. These counts comprise "shares," "likes," and "comments". Aggregates are provided for the each of these social shares based on the total number of Facebook users who have shared, liked, or commented on a particular URL, respectively. Shares, likes, and comments that are public (i.e., are not restricted to specific user groups) contain further information such as the user name and time of event. Available data are further described in the Graph API documentation: https://developers.facebook.com/docs/graph-api.	2016/02/05
#2	Provide a clear definition of each metric.	A1	Facebook provides the following event counts: • **Shares** represent the number of times a particular URL has been shared by Facebook users on their own or other users' Facebook walls. Shares are thus posts that include a URL. Shares that are made available publicly (i.e., those for which access is not restricted to a certain user group) include the information about by whom and when the URL was shared. Each user can share the same URL multiple times; aggregated share counts thus do not necessarily reflect the number of unique users who have shared that URL.	2016/02/05

			• **Likes** represent the number of times a particular post, share or comment has been "liked" (i.e., as indicated by a click on the Facebook "like button") by Facebook users. Each Facebook user can only like each post or comment once, but can "unlike" the same post, which removes the particular like. Therefore, each like count represents the sum of users that have liked a URL at a particular moment in time. • **Comments** represent the number of times Facebook users have commented on their own or others' posts, shares, or comments. Each user can comment on the same post, share, or comment multiple times; aggregated comment counts do thus not necessarily reflect the number of unique users who have commented on a particular URL.	
#3	Describe the method(s) by which data are generated or collected and how data are maintained over time.	T1, T2, R1	The Graph API is well documented, but information about how the counts are generated is not available. No information about users is provided.	2016/02/05
#4	Describe all known limitations of the data.	A3	For pages that are not freely accessible—e.g., when a publisher requires cookies or a manual selection of options—Facebook is not able to properly determine the canonical URL and does thus not provide the correct online event counts. Facebook events are only available via the Graph API, further information regarding the limitation of the provided data are not available.	2016/02/05

#5	Provide a documented audit trail of how and when data generation and collection methods change over time and list all known effects of these changes. Documentation should note whether changes were applied historically or only from change date forward.	R1, R2, R3	Facebook regularly updates its API, sometimes including backwards-incompatible changes to how share, like, and comment counts are generated. API changes are versioned and documented publicly at https://developers.facebook.com/docs/apps/changelog and https://developers.facebook.com/blog/. The latest API is v.2.5, released October 7, 2015.	2016/02/05
#6	Describe how data are aggregated.	T2	The Graph API is well documented, but information about how the counts are aggregated is not available. https://developers.facebook.com/docs/sharing/webmasters/crawler.	2016/02/05
#7	Detail how often data are updated.	T3	In the Graph API, Facebook provides a timestamp that documents when this information was last updated.	2016/02/05
#8	Describe how data can be accessed.	T4	The Graph API is openly available. Users need to register for an API key for higher rate-limits.	2016/02/05
#9	Confirm that data provided to different data aggregators and users at the same time are identical and, if not, how and why they differ.	R4	As far as is known, all users get the same data from the Graph API.	2016/02/05

#10	Confirm that all retrieval methods lead to the same data and, if not, how and why they differ.	R4	Facebook has permission levels. The application retrieving the data must have the open key. Users can make their accounts public or private and can change the privacy setting of single posts from public, to restricted to certain user groups, to private and vice versa. Facebook data retrieved via the API represent a certain moment in time. If data posted at time A are changed at time B, results retrieved at A will differ from those retrieved with the same retrieval method at B. Changes in the API may change query results.	2016/02/05
#11	Describe the data-quality monitoring process.	T5, A2	Facebook has a built-in control at multiple entry points to attempt accuracy. However, further information about the data-quality monitoring process is not available.	2016/02/05
#13	Provide a process for reporting and correcting data or metrics that are suspected to be inaccurate.	A2	Users can submit a request to the Facebook developers' bug site. However, there is insufficient information about what actions Facebook will take in response to the request, unless an API retrieval change is needed. It does not appear that Facebook will adjust the data, but rather just correct the API.	2016/02/05

NISO Altmetrics Working Group C "Data Quality" – Code of Conduct Self-Reporting Table

Example for data aggregator: Mendeley

Item	Description	Supports CoC Recommendation	Aggregator / Provider Submission*	Last update of self-reporting table**
#1	List all available data and metrics (providers and aggregators) and altmetric data providers from which data are collected (aggregators).	T1	Mendeley offers total readership statistics per scholarly document added by Mendeley users to their private libraries. These statistics include academics status (students, professors, librarians, etc.), disciplines (sub disciplines) and countries of the Mendeley users, which can be selected by users from a list provided by Mendeley. Some of this demographic information is currently mandatory (e.g., discipline), while some is optional (e.g., country). This influences the extent to which this data are available for Mendeley readership counts. Mendeley offers a free open API for collecting the readership metrics including aggregated demographic information in a very fast way. The API is well documented: https://api.mendeley.com/apidocs.	2016/07/25
#2	Provide a clear definition of each metric.	A1	Mendeley readers, aka “saves” is the number of copies of a metadata record in our database at a given point in time.	2016/07/25

#3	Describe the method(s) by which data are generated or collected and how data are maintained over time.	T1, T2, R1	The count of readers of a document is initialized by a batch clustering process which operates on the extracted metadata from all the documents uploaded by Mendeley users. This process aggregates all of the same document on the basis of filehash (which becomes part of the metadata) and then adds to the cluster documents which have different filehashes but which share the same title, author list, and year of publication. We do not currently use the DOI or other identifier such as Arxiv ID or PMID to determine which cluster a document belongs to, as not all of the documents in the catalog have these identifiers. While the batch clustering process runs roughly monthly across the whole catalog to re-create the document clusters and create a new count for everything, based on the number of metadata records present in each cluster, the existing counts are incremented (as opposed to being re-calculated from scratch) nearly instantaneously between batch clustering runs every time a user adds a metadata record to their Mendeley library. If this new addition can be associated with a pre-existing cluster, the count of readers is incremented by one. If the document is novel to Mendeley, it's not given a readership value until the batch process is run. This means that for most documents, readership is incremented nearly instantaneously, unless the document is new to Mendeley, in which case there may be as much as a month lag for it to start accumulating readers, though the delay is usually shorter. A user need not have opened, annotated, or scrolled through the PDF for us to count it. The number is strictly the number of duplicate documents in a cluster generated by the batch process. Therefore, we agree that "saves" is probably a more accurate term, and we may in the future add other metrics which reflect other types of activities	2016/07/25

	carried out by researchers using Mendeley. A user joining a public or private group to which a document has been added won't cause counts for that document to increase, as another metadata record doesn't get created when they do so, but if they didn't previously have their own copy and they make a copy of the document by adding it to their own non-group folders, then this will increment the count. When a user deletes their account and all their documents, the readership of that document doesn't change until the batch clustering process is re-run and the new number of metadata records is generated. The same applies when a user deletes a record from their personal library, even if they're still a member of a group in which that document is located. In summary, the count of records can increase nearly instantaneously, but only decreases periodically. There are a few other ways readership numbers can increase or decrease non-monotonically, which are describe below. Often, files will differ in filehash and less often, they may have incorrect user-entered data as well. When this happens, the clustering process may create a separate cluster or clusters from the main cluster, and as a result, the number of readers is now split among separate entries in the catalog. Requesting the readers for this document could return values for only one of the entries, resulting in a lower than actual number of readers, until the clusters are re-merged. As we improve our technology and as users clean up or edit their incorrect entries, these separate clusters tend to get added to the main cluster on the subsequent batch run. This can cause a sudden jump in readership, depending on the sizes of the clusters that were merged and the how many copies of that record were deleted from user libraries in the meantime. If large amounts of documents were deleted between runs of the

	batch process, there may be a sudden drop in readership. Another way to get incorrect numbers is if multiple clusters exist and they have the same title, but only one smaller cluster has an external database identifier such as a DOI, then an API query based on title and and an API query based on DOI would return different values. However, these situations are rare, and they are decreasing as more scholarship is “born digital”. This batch re-initialization process is not run on a fixed interval, was last run in mid-March and most recently in mid-May 2016. Over the course of the year, we will work towards moving from reporting the aggregated number of readers as above to an event-driven system where readership events are pushed to those who have subscribed to them. These events will have timestamps and may look something like this: "Doc ID 3aa9c906-ce62-34b8-b54e-6b767858f473 was added by a Postdoc in Biomedical Sciences at 2016-05-08T19:48:09Z" (the actual API response will be in JSON) This may not change the way the numbers are displayed in the Mendeley interface and should not affect overall readership numbers, either. These events will be pushed via API to the Mendeley Catalog and any other subscribers, such as Scopus, Altmetric.com, and Crossref's CED. Most likely, it will require a second API call to retrieve extended metadata about the document, such as title, authors, abstract, etc. In the future, we may add information to API responses or events pertaining to a document, such as historical readership levels, (non-personally identifying) institutional affiliation of a reader, whether the document has been opened in the PDF reader, annotated, etc.

#4	Describe all known limitations of the data.	A3	The API requires an API key and uses rate limits. Readership data are anonymous. The publicly available data do not include information about the identity of each person contributing a read, so it is not possible to externally verify whether the readership count actually reflects the number of Mendeley users of a document, though examination of the values over time can provide some assurance that the numbers aren't being altered by processes other than addition and removal of documents from Mendeley. Some publications are saved in Mendeley but their readership counts are not available; for these, the message "readership counts are being calculated" is provided. This is more common with documents which have only recently be added to the Mendeley catalog. Although selecting an academic status and discipline are currently obligatory when creating an account in Mendeley, some publications with total readerships statistics have been reported to not have any information about the users' academic status. It's unclear how this can happen and the observation of a lack of status may be due to database, network, retrieval, or analysis error. Often, files will differ in filehash and less often, they may have incorrect user-entered data as well. When this happens, the clustering process may create a separate cluster or clusters from the main cluster, and as a result, the number of readers is now split among separate entries in the catalog. Requesting the readers for this document could return values for only one of the entries, resulting in a lower than actual number of readers, until the clusters are re-merged. This appears to someone searching the	2016/07/25

			Mendeley catalog as duplicates in the catalog. As we improve our technology and as users clean up or edit their incorrect entries, these separate clusters tend to get added to the main cluster on the subsequent batch run. This can cause a sudden jump in readership, depending on the sizes of the clusters that were merged and the how many copies of that record were deleted from user libraries in the meantime. If large amounts of documents were deleted between runs of the batch process, there may be a sudden drop in readership. Another way to get incorrect numbers is if multiple clusters exist and they have the same title, but only one smaller cluster has an external database identifier such as a DOI, then an API query based on title and and an API query based on DOI would return different values. However, these situations are rare, and they are decreasing as more scholarship is “born digital”.	
#5	Provide a documented audit trail of how and when data generation and collection methods change over time and list all known effects of these changes. Documentation should note whether changes were applied historically or only from change date forward.	R1, R2, R3	Information regarding changes of generating and calculating readership counts over time is available. API changes are documented at https://api.mendeley.com/apidocs.	2016/07/25
#6	Describe how data are aggregated.	T2	Often, files will differ in filehash and less often, they may have incorrect user-entered data as well. When this happens, the clustering process may create a separate cluster or clusters from the main cluster, and as a result, the number of readers is now split among separate entries	2016/07/25

			in the catalog. Requesting the readers for this document could return values for only one of the entries, resulting in a lower than actual number of readers, until the clusters are re-merged. As we improve our technology and as users clean up or edit their incorrect entries, these separate clusters tend to get added to the main cluster on the subsequent batch run. This can cause a sudden jump in readership, depending on the sizes of the clusters that were merged and the how many copies of that record were deleted from user libraries in the meantime. If large amounts of documents were deleted between runs of the batch process, there may be a sudden drop in readership. Another way to get incorrect numbers is if multiple clusters exist and they have the same title, but only one smaller cluster has an external database identifier such as a DOI, then an API query based on title and and an API query based on DOI would return different values. However, these situations are rare, and they are decreasing as more scholarship is “born digital”.	
#7	Detail how often data are updated.	T3	Two update processes occur, detailed above. The batch process, which re-calculates the number of documents, including discipline and academic statuses, is run approximately monthly. The real-time process occurs whenever a document is added to a user’s library. At the moment, there are no timestamps delivered with the readership data. We are working towards moving from reporting the aggregated number of readers to an event-driven system where readership events are pushed to those who have subscribed to them. These events will have timestamps and may look something like this: "Doc ID 3aa9c906-ce62-34b8-b54e-6b767858f473 was	2016/07/25

			added by a Postdoc in Biomedical Sciences at 2016-05-08T19:48:09Z" (the actual API response will be in JSON). An exception is that a Mendeley user may see historical readership for his own papers (i.e., those he or she has authored); for these papers monthly historical readership data are provided for the last 12 months. .	
#8	Describe how data can be accessed.	T4	Data can be accessed via the Mendeley catalog (https://www.mendeley.com/research-papers) or the open API (https://api.mendeley.com/apidocs). The API includes detailed information about how to use the API for data extraction: http://dev.mendeley.com/methods/?shell#introduction. However, not all data listed in the documentation (e.g., date created) are available via the public API.	2016/07/25
#9	Confirm that data provided to different data aggregators and users at the same time are identical and, if not, how and why they differ.	R4	All users get the same data from the Mendeley API.	2016/07/25
#10	Confirm that all retrieval methods lead to the same data and, if not, how and why they differ.	R4	Mendeley readership counts retrieved through the web catalog and the API for the same document at the same time may differ because total readership counts and readership counts per academic status and discipline are not calculated simultaneously. Using different metadata (e.g., DOI, PMID, document title etc.) and different retrieval methods (web catalog vs. API) may result in different readership counts for the same document, only in the case of duplicates where one duplicate has the identifier used for the query and one doesn't.	2016/07/25

#11	Describe the data-quality monitoring process.	T5, A2	The batch process which re-calculates the number of readers is periodically re-run, approximately monthly, to combine clusters of duplicates which have had corrections made to their metadata. Documents which have insufficient metadata (missing titles, authors, etc) are not displayed in the catalog.	2016/07/25
#13	Provide a process for reporting and correcting data or metrics that are suspected to be inaccurate.	A2	Mendeley offers a support portal (http://support.mendeley.com) for questions and reporting problems using Mendeley and a feedback forum (https://feedback.mendeley.com) for suggestions for improvements. One can also correct the suspected incorrect entry in their personal library. If the inaccuracy is due to missing information, the new information will be added to the catalog entry.	2016/07/25

NISO Altmetrics Working Group C "Data Quality" – Code of Conduct Self-Reporting Table

Example for data aggregator: Plum Analytics

Item	Description	Supports CoC Recommendation	Aggregator / Provider Submission*	Last update of self-reporting table**
#1	List all available data and metrics (providers and aggregators) and altmetric data providers from which data are collected (aggregators).	T1	Plum Analytics has a suite of products called PlumX. A description of each PlumX product can be found on our product pages. PlumX collects metrics data from many sources and groups them into 5 categories of metrics. Sources for each category are defined below: *Usage* – bepress, bit.ly, CABI, Dryad, DSpace, EBSCO, ePrints, Facebook, figshare, Forbes, Github, Institutional Repositories, OJS Journals, PLOS, PubMedCentral, Pure, RePEc, Slideshare, SSRN, WorldCat.(See more information at http://plumanalytics.com/learn/about-metrics/usage-metrics/) *Captures* – Delicious, EBSCO, GitHub, Goodreads, Mendeley, SlideShare, Vimeo, YouTube (See more information at http://plumanalytics.com/learn/about-metrics/capture-metrics/) *Mentions* – Amazon, blogs, Facebook, GitHub, Goodreads, mainstream media, Reddit, Slideshare, SourceForge,	2016/03/31

			StackExchange, Vimeo, YouTube, Wikipedia (See more information at http://plumanalytics.com/learn/about-metrics/mention-metrics/) *Social Media* – Amazon, Facebook, Figshare, Google Plus, Goodreads, SourceForge, Reddit, Twitter, Vimeo, YouTube (See more information at http://plumanalytics.com/learn/about-metrics/social-media-metrics/) *Citations* – CrossRef, PubMed Central, PubMed Central Europe, RePEc, Scopus (for mutual customers), SSRN, United States Patent and Trademark Office (See more information at http://plumanalytics.com/learn/about-metrics/citation-metrics/)	
#2	Provide a clear definition of each metric.	A1	The PlumX Suite provides the raw usage, capture, mention, social media, or citation counts by source, e.g., the number of Wikipedia articles we have mined about a specific book or article. Raw counts can be viewed in the application, embedded in other sites through widgets, or exported. We strive to keep the naming of these metrics consistent with how the source we are harvesting them from. E.g., Mendeley "readers" and Delicious "bookmarks." We have over 35 specific, granular metrics that we calculate. A complete list and definition of each can be found at http://plumanalytics.com/learn/about-metrics/.	2016/03/31

#3	Describe the method(s) by which data are generated or collected and how data are maintained over time.	T1, T2, R1	Data are collected via a range of methods, largely via data provider APIs, third-party provider APIs, FTP data transfers, OAI-PMH harvesting, web crawlers and RSS feeds. The data is maintained over time as described in section #7 below.	2016/03/31
#4	Describe all known limitations of the data.	A3	When PlumX begins utilizing a source of metrics, the amount of historic data from that source will vary. Our text mining for calculating mentions of artifacts often requires that the artifact is mentioned by URL or another scholarly identifier to associate the mention with the artifact. Links to original posts on third party blog and news sources may break or posts may be deleted. Our match and merge algorithms for combining and aggregating metrics from all the different online locations where it is published (as described in #6 below) depend upon a knowledge base of how to cross-walk different identifiers (like going from a DOI to a PubMed ID). If there are errors in this crosswalk data, it is possible to "over-merge" a record. Any examples of this can be reported to PlumXSupport@ebsco.com. Similarly, if there is not enough data to automatically merge two preprints from two different services together, they may also need to be manually identified and merged by the PlumX staff.	2016/03/31

			We license twitter data in PlumX directly through Twitter/GNIP. We have a filtered view of all tweets based upon the domain names of the links in the tweets. Our historic twitter data begins on January 1, 2011. We accommodate URL shorteners and have match and merge technology for combining tweets from multiple, separate URLs into a single view for a given artifact. However, if the original artifact is published at a domain that we do not yet track, once identified and added by the Plum Analytics team, twitter mentions for that domain will only begin to be counted from the time the new domain is added.	
#5	Provide a documented audit trail of how and when data generation and collection methods change over time and list all known effects of these changes. Documentation should note whether changes were applied historically or only from change date forward.	R1, R2, R3	In March 2016, Plum Analytics reported that tracking of an audit trail for PlumX would begin in April 2016.	2016/03/31
#6	Describe how data are aggregated.	T2	Each research output in PlumX is called an artifact. PlumX tracks over 40 different types of artifacts including books, book chapters, conference proceedings, journal articles, slide presentations, videos, etc. A full list of artifact types can be found at http://plumanalytics.com/learn/about-artifacts/. Online events about different versions of the same artifact (Publisher + Green Open Access + Preprint + Aggregated	2016/03/31

			versions + A&I) are collected and aggregated based on algorithms that examine matching identifiers (such as DOI, ISBN, or URI) across versions. Usage, Capture, Social Media, and Mention metrics counts are summed across all versions of each artifact. Citation counts are not added together across different providers since this would result in double-counting the citations. Instead, we represent the cited by count for an artifact as the maximum value reported. Within PlumX Dashboards and PlumX +Grants, metrics are aggregated based on researcher, grant, or any other customer-defined group hierarchy for comparisons at the aggregate level. Group hierarchies are defined by each client and might include grouping by school or department, by geography or by journal issue or volume. Within PlumX Benchmarks, metrics are aggregated per institution, to allow comparisons between all institutions who have received NIH funding from 2012-2015. They are also aggregated at the NIH grant level, so that users can see the ROI on any NIH grant.	
#7	Detail how often data are updated.	T3	Metrics data is kept up to date by re-harvesting on the frequency that the source of the metrics updates. For some data providers, like twitter, we license part of the twitter firehose, and we get the metrics in real time. For other sources, we get daily updates of metrics. For example, we update usage data from EBSCO on a daily basis. For other providers, they only give us their data on a weekly or monthly basis.	2016/03/31

			Every 3-4 hours we refresh the entire PlumX index to have the most up to date metrics from all of our sources.	
#8	Describe how data can be accessed.	T4	Plum Analytics provides access to the data via end-user interfaces, widgets that customers can integrate to their site, free artifact widgets, or via our open Application Programming Interface (API). Article-level widgets can be accessed by the following identifier types: • arxiv • cabi_abstract_id • doi • github_repo_id • isbn • nct_id • oclc • pmid • repo_url • slideshare_slideshow_id • sourceforge_repo_id • ssrn_id • us_patent_publication_id • vimeo_video_id • youtube_video_id Author-level widgets can be accessed by their PlumX user id. This user id can also be associated with both publicly available author identifiers such as ORCID, or with institution-specific unique author identifiers. Individual customers of PlumX can decide if their PlumX user ids are public or private.	2016/03/31

			Group-level widgets can be accessed by their PlumX group id. These group ids can be mapped to and associated with institution-specific group ids. Individual customers of PlumX can decide if their PlumX group ids are public or private. Grant-level widgets can be accessed by their PlumX grant id. These grant ids can be mapped to and associated with institution-specific or funder-specific grant ids. Individual customers of PlumX can decide if their PlumX grant ids are public or private. Documentation about our widgets and API is available at https://plu.mx/developers.	
#9	Confirm that data provided to different data aggregators and users at the same time are identical and, if not, how and why they differ.	R4	All Plum Analytics applications are based on the same set of data. Users access the same data across each tool, except where data is restricted according to access level. Access level varies across products, but all products require a subscription to access all data. Artifact-level PlumX pages are free and publicly accessible; they provide access to all our article-level metrics.	2016/03/31
#10	Confirm that all retrieval methods lead to the same data and, if not, how and why they differ.	R4	We eat our own dog food at Plum Analytics, and the entire PlumX product suite is developed on top of the same API we expose to customers. Different retrieval methods will lead to the same data.	2016/03/31
#11	Describe the data-quality monitoring process.	T5, A2	Data quality is monitored in a variety of ways. Some sources of data (such as the set of blogs that PlumX covers) are hand-curated to focus on research-oriented blogs. This set of blogs is created in conjunction with customer driven requests, and metadata librarians on the	2016/03/31

			Plum Analytics team facilitate this process. Outlier analysis is done on our data to identify and investigate potential gaming or erroneous metrics. Our match and merge technology for bibliographic data prioritizes high quality sources like CrossRef over unedited sources like when our crawlers harvest data off of the open web. Each new source of metrics goes through a rigorous data quality assurance cycle before being added to PlumX.	
#13	Provide a process for reporting and correcting data or metrics that are suspected to be inaccurate.	A2	Suspected inaccurate metrics or data can be reported to PlumXSupport@ebsco.com.	2016/03/31

NISO Altmetrics Working Group C "Data Quality" – Code of Conduct Self-Reporting Table

Example for data aggregator: Twitter

Item	Description	Supports CoC Recommendation	Aggregator / Provider Submission*	Last update of self-reporting table**
#1	List all available data and metrics (providers and aggregators) and altmetric data providers from which data are collected (aggregators).	T1	Twitter provides data through both its web interface (http://www.twitter.com) and its APIs. The API specifications are documented here: https://dev.twitter.com/overview/documentation. Twitter explicitly provides information on four main types of objects: Tweets, Users, Entities, and Places. Each type of object has many metadata fields and each field has specific meanings. Some of this available data may be used as metrics: • **followers_count**: The number of followers a particular user currently has. • **favorite_count**: Indicates approximately how many times a particular tweet has been "liked" by Twitter users. • **retweet_count**: Number of times a particular tweet has been retweeted. Some metrics may also be deduced from the API calls, for example, the total number of items returned from a search API query, such as the number of tweets mentioning a DOI.	2016/02/05

#2	Provide a clear definition of each metric.	A1	No detailed information is provided to provide a clear definition of each metric.	2016/02/05
#3	Describe the method(s) by which data are generated or collected and how data are maintained over time.	T1, T2, R1	Some known limitations of Twitter metrics include: • Twitter data consumers should tolerate the addition of new fields and variance in ordering of fields with ease. Not all fields appear in all contexts. It is generally safe to consider a nulled field, an empty set, and the absence of a field as the same thing. • Tweets found in search results vary somewhat in structure from other API results. • Twitter's search service and, by extension, the Search API is not meant to be an exhaustive source of tweets. Not all tweets will be indexed or made available via the search interface. • The Twitter Search API is part of Twitter's REST (Representational State Transfer) API. It allows queries against the indices of recent or popular tweets and behaves similarly to, but not exactly like, the Search feature available in Twitter mobile or web clients, such as Twitter.com search. The Twitter Search API searches against a sampling of recent tweets published in the past seven days (as indicated by the API documentation as of Feb 1, 2016).	2016/02/05
#4	Describe all known limitations of the data.	A3		2016/02/05

#5	Provide a documented audit trail of how and when data generation and collection methods change over time and list all known effects of these changes. Documentation should note whether changes were applied historically or only from change date forward.	R1, R2, R3	The Twitter API is versioned, although an audit trail does not appear to exist.	2016/02/05
#6	Describe how data are aggregated.	T2	Twitter provides information on events based on different API calls. Aggregation of Twitter metrics depends on the API calls. Users or altmetric data aggregators decide whether and how to aggregate Twitter metrics such as the number of tweets and retweets of a document.	2016/02/05
#7	Detail how often data are updated.	T3	It is generally expected that the Twitter data are updated in real time, but what real time means is unknown.	2016/02/05
#8	Describe how data can be accessed.	T4	The Twitter API documentation provides information on access. OAuth is required for accessing the REST API, and subject to rate limit. The Public Streaming API provides a sample of all tweets. Access to the Twitter Firehose, the full tweets stream, requires special permission.	2016/02/05
#9	Confirm that data provided to different data aggregators and users at the same time	R4	It is not guaranteed that all users get the same data. It has been shown that timeline data has random omissions on recent tweets for different users, and the Search API is not	2016/02/05

	are identical and, if not, how and why they differ.		meant to be complete but provides access to a sample of recent Tweets published in the past seven days (see #3).	
#10	Confirm that all retrieval methods lead to the same data and, if not, how and why they differ.	R4	It is not guaranteed that different retrieval methods result in the same data. It has been shown that followers_count, favorite_count, and retweet_count do not immediately reflect recent changes.	2016/02/05
#11	Describe the data-quality monitoring process.	T5, A2	A web service provides information about the API operational health status in the most recent week, e.g., “operating normally,” “has performance issues,” or “encounter interruptions”: https://dev.twitter.com/overview/status.	2016/02/05
#13	Provide a process for reporting and correcting data or metrics that are suspected to be inaccurate.	A2	No information is available on how inaccurate data or metrics can be corrected.	2016/02/05

NISO Altmetrics Working Group C "Data Quality" – Code of Conduct Self-Reporting Table

Example for data aggregator: Wikipedia

Item	Description	Supports CoC Recommendation	Aggregator / Provider Submission*	Last update of self-reporting table**
#1	List all available data and metrics (providers and aggregators) and altmetric data providers from which data are collected (aggregators).	T1	The core metric one can derive from Wikipedia is mentions of DOIs in Wikipedia articles. Another metric one could use for altmetrics is page views, but it seems that most aggregators only use number of mentions of, for example, a DOI, and not how many views occur on a page where a DOI is mentioned. Wikipedia does not provide DOI mentions per article; this data needs to be harvested from Wikipedia content.	2016/02/05
#2	Provide a clear definition of each metric.	A1	Data refers to Wikipedia content (its pages). This data are collected as users edit pages. It is unclear how soon this data are available via the API: https://www.mediawiki.org/wiki/API:Main_page.	2016/02/05

#3	Describe the method(s) by which data are generated or collected and how data are maintained over time.	T1, T2, R1	Wikipedia provides API access to all its content and records changes when users edit pages. In the context of altmetrics, Wikipedia data are aggregated by many aggregators (e.g., Altmetric, Crossref CED, ImpactStory, Lagotto), which extract information about Wikipedia pages that mention scholarly document identifiers such as DOIs. Aggregation is not performed by Wikipedia but by data aggregators or users. For example, the Lagotto instance for PLOS articles reports the Wikipedia mentions by aggregating all DOI mentions in the top 25 Wikipedia language sites.	2016/02/05
#4	Describe all known limitations of the data.	A3	The limitations of provided data are unknown.	2016/02/05
#5	Provide a documented audit trail of how and when data generation and collection methods change over time and list all known effects of these changes. Documentation should note whether changes were applied historically or only from change date forward.	R1, R2, R3	Content on Wikipedia can change through time as article pages are edited. This may pose a problem for consistency as a data request at time X may give a different result than at X + 1 year. Because of the above, Wikipedia is one of the data providers where metrics may actually go down, something that we (almost) never see for citations or downloads.	2016/02/05
#6	Describe how data are aggregated.	T2	Wikipedia provides information on events based upon changes to Wikipedia pages. Aggregation of Wikipedia metrics depends on the API calls. Users or altmetric data aggregators decide whether and how to aggregate Wikipedia metrics, such as the number of times a document is mentioned, using different identifiers (e.g.,	2016/02/05

			DOI, URL, PMID) or in Wikipedia articles in different languages.	
#7	Detail how often data are updated.	T3	It is unclear how soon after a change to a Wikipedia page is made the data on the changes is available via the API.	2016/02/05
#8	Describe how data can be accessed.	T4	Wikipedia data can be accessed via the API documented at https://www.mediawiki.org/wiki/API:Main_page, and bulk downloads can be fetched at https://dumps.wikimedia.org/.	2016/02/05
#9	Confirm that data provided to different data aggregators and users at the same time are identical and, if not, how and why they differ.	R4	Data provided through via the API at the same time is identical for all users.	2016/02/05
#10	Confirm that all retrieval methods lead to the same data and, if not, how and why they differ.	R4	It is assumed that different retrieval methods lead to the same results.	2016/02/05
#11	Describe the data-quality monitoring process.	T5, A2	No information is provided regarding the data-quality monitoring process.	2016/02/05

#13	Provide a process for reporting and correcting data or metrics that are suspected to be inaccurate.	A2	The core metric one can derive from Wikipedia is mentions of DOIs in Wikipedia articles. Another metric one could use for altmetrics is page views, but it seems that most aggregators only use number of mentions of, for example, a DOI, and not how many views occur on a page where a DOI is mentioned. Wikipedia does not provide DOI mentions per article; this data needs to be harvested from Wikipedia content.	2016/02/05

Appendix C: Glossary

The literature of altmetrics is rich with terminology that requires or implies more specific definitions. The following glossary represents a selection of these terms.

Activity. Viewing, reading, saving, diffusing, mentioning, citing, reusing, modifying, or otherwise interacting with scholarly outputs.

Altmetric data aggregator. Tools and platforms that aggregate and offer online events as well as derived metrics from altmetric data providers, for example, Altmetric.com, Plum Analytics, PLOS ALM, ImpactStory, and Crossref.

Altmetric data provider. Platforms that function as sources of online events used as altmetrics, for example, Twitter, Mendeley, Facebook, F1000Prime, Github, SlideShare, and Figshare.

Attention. Notice, interest, or awareness. In altmetrics, this term is frequently used to describe what is captured by the set of activities and engagements generated around a scholarly output.

Bibliometrics. A set of quantitative methods used to measure, track, and analyze scholarly literature; an established field of research concerning the application of mathematical and statistical analysis to print-based scholarly literature. Sometimes defined as a branch of library and information science.

Content platform provider. Any digital platform that hosts and enables discovery of scholarly/research outputs, such as library services, abstract and indexing databases, and institutional repositories.

Engagement. The level or depth of interaction between users and scholarly outputs, typically based upon the activities that can be tracked within an online environment. See also *Activity*.

Impact. The subjective range, depth, and degree of influence generated by or around a person, output, or set of outputs, both within the scholarly world and in wider society. Interpretations of impact vary depending on its placement in the research ecosystem.

Metrics. A method or set of methods for purposes of measurement.

Online event. A recorded entity of online activities related to scholarly output, used to calculate metrics.

Reach. The user-focused sphere of influence of a scholarly output, as defined contextually by its placement within the research ecosystem. Reach is closely related to *Impact*.

Research ecosystem. The community or communities involved in the generation, presentation, and evaluation of scholarly research. These communities may be comprised of myriad participants, technologies, and concepts.

Research output. See *Scholarly output*.

Research quality. The assessment of a scholarly output's self-contained value and potential for impact as determined by qualified subject experts. In most cases, assessment of research quality presumes the application of qualitative methods of evaluation. Research quality is not necessarily correlated with research impact.

Scholarly output. A product created or executed by scholars and investigators in the course of their academic and/or research efforts. Scholarly output may include but is not limited to journal articles, conference proceedings, books and book chapters, reports, theses and dissertations, edited volumes, working papers, scholarly editions, oral presentations, performances, artifacts, exhibitions, online events, software and multimedia, composition, designs, online publications, and other forms of intellectual property. The term *scholarly output* is sometimes used synonymously with *research outputs*.

Stakeholder. An agent or actor who creates, consumes, applies, or is otherwise invested in altmetrics or a specific altmetric indicator.

Conventional metrics. The set of metrics based upon the collection, calculation, and manipulation of scholarly citations, often at the journal level. Specific examples include raw and relative (field-normalized) citation counts and the Journal Impact Factor.

Usage. A specific subset of activity based upon user access to one or more scholarly outputs, often in an online environment, and measured by organizations such as COUNTER. Common examples include HTML accesses and PDF downloads.

Appendix D: Combined Bibliography

Alperin, J.P. "Exploring Altmetrics in an Emerging Country Context." *Altmetrics14: Expanding Impacts and Metrics, Workshop at Web Science Conference 2014*. http://dx.doi.org/10.6084/m9.figshare.1041797

Alperin, J.P. "Geographic Variation in Social Media Metrics: An Analysis of Latin American Journal Articles." *Aslib Journal of Information Management* 67, no 3. (2015): 289–304. http://doi.org/10.1108/AJIM-12-2014-0176

Ball, A. & M. Duke. *How to Track the Impact of Research Data with Metrics: DCC How-to Guides*. Edinburgh: Digital Curation Centre, 2015. http://www.dcc.ac.uk/resources/how-guides

Barnes, C. "The Use of Altmetrics as a Tool for Measuring Research Impact." *Australian Academic & Research Libraries* 46, no. 2 (2015): 121-134. http://dx.doi.org/10.1080/00048623.2014.1003174

Borgman, C. (2013). "Response to 'The Future of Research Libraries.'" In Oliver Smithies Fellow and Lecturer, Balliol College. Oxford Internet Institute. Available online: http://www.oii.ox.ac.uk/events/?id=569

Borgman, C.L., N. Enyedy, & J.C. Wallis (2007). "Little Science Confronts the Data Deluge: Habitat Ecology, Embedded Sensor Networks, and Digital Libraries," *International Journal on Digital Libraries* 7 (1-2): 17-30. http://doi.org/10.1007/s00799-007-0022-9

Cai, L. & Y. Zhu. "The challenges of data quality and data quality assessment in the big data era." *Data Science Journal* 14, no. 2. (2015). http://dx.doi.org/10.5334/dsj-2015-002

California Digital Library. "The Name-to-Thing (N2N) Resolver." (2015). http://n2t.net

Callaghan, S., T. Carpenter, & J.E. Kratz (2015). "Walk Softly and Carry a Large Carrot: How To Give Credit for Academic Work." In: FORCE2015, 12-13 January 2015, Oxford, UK. http://cedadocs.badc.rl.ac.uk/1125/1/FORCE2015_poster_final.pdf

CASRAI. "Research Dataset-Level Metrics." (2015). http://ref.casrai.org/Research_Dataset-Level_Metrics

Chin Roemer, R. & Borchardt, R. "Institutional Altmetrics and Academic Libraries." *Information Standards Quarterly* 25, no. 2 (2013): 15-19. http://dx.doi.org/10.3789/isqv25no2.2013.03

Chin Roemer, R. & Borchardt, R. *Meaningful Metrics: A 21st Century Librarian's Guide to Bibliometrics, Altmetrics, and Research Impact*. Chicago ACRL Press, 2015.

CODATA International Council for Science: Committee on Data for Science and Technology. "CODATA-ICSTI Data Citation Standards and Practices." (2016). http://www.codata.org/task-groups/data-citation-standards-and-practices

Colledge, L. *Snowball Metrics Recipe Book*. Amsterdam, The Netherlands: Snowball Metrics Program Partners, 2014.

Committee on Institutional Cooperation. "Developments in the US: STAR & U METRICS." https://www.cic.net/docs/default-source/umetrics/umetrics-presentation-(weinberg).pptx?sfvrsn=2

Committee on Institutional Cooperation. "The UMETRICS Initiative." https://www.cic.net/docs/default-source/umetrics/umetrics-synthesis-document.pdf?sfvrsn=4

COPDESS. "COPDESS: Coalition on Publishing Data in the Earth and Space Sciences." (2015). http://www.copdess.org/

Costas, R., Z. Zahedi, & P. Wouters. "Disentangling the Meaning of 'Altmetrics': Content Analysis of Web of Science Scientific Publications." *Proceedings of the Altmetrics14: Expanding Impacts and Metrics Workshop, June 23, 2014* (2014). http://dx.doi.org/10.6084/m9.figshare.1041770

Costas, R., Z. Zahedi, & P. Wouters. "Do Altmetrics Correlate with Citations? Extensive Comparison of Altmetric Indicators with Citations from a Multidisciplinary Perspective." *Journal of the Association for Information Science and Technology* 66, no. 10 (2014): 2003–2019. http://arxiv.org/abs/1401.4321

COUNTER. "The COUNTER Code of Practice." (2016). https://www.projectcounter.org/code-of-practice-sections/general-information/

Data Citation Synthesis Group: Joint Declaration of Data Citation Principles. Martone M. (ed.) San Diego CA: FORCE11; 2014. https://www.force11.org/group/joint-declaration-data-citation-principles-final

Data Level Metrics Project. Making Data Count: Project to develop Data-Level Metrics. http://mdc.lagotto.io/

DataCite. "Welcome to DataCite." https://www.datacite.org/

DLI Service. The Data Literature Interlinking. http://dliservice.research-infrastructures.eu/#/

Eysenbach, G. "Can Tweets Predict Citations? Metrics of Social Impact Based on Twitter and Correlation with Traditional Metrics of Scientific Impact." *Journal of Medical Internet Research* 13 no. 4, e123 (2011). http://www.jmir.org/2011/4/e123/

Fear, K. M. "Measuring and anticipating the impact of data reuse." University of Michigan. (2013). http://deepblue.lib.umich.edu/handle/2027.42/102481

Force11. **"**Data Citation Implementation Group.**"** (2016). https://www.force11.org/group/data-citation-implementation-group

Force11. **"**Data Citation Implementation Pilot (DCIP)" (2016). https://www.force11.org/group/dcip

Force, M.M. & N.J. Robinson. (2014). "Encouraging data citation and discovery with the data citation index," Journal of Computer-Aided Molecular Design 28 (10): 1043-1048. http://doi.org/10.1007/s10822-014-9768-5

Galligan, F. & S. Dyas-Correia. "Altmetrics: Rethinking the Way We Measure." *Serials Review* 39, no.1 (March 2013): 56-61. http://dx.doi.org/10.1016/j.serrev.2013.01.003

Glänzel, W. & J. Gorraiz. "Usage Metrics Versus Altmetrics: Confusing Terminology?" *Scientometrics* 102, no. 3 (2015): 2161-2164. http://dx.doi.org/10.1007/s11192-014-1472-7

Google Scholar. "Inclusion Guidelines for Webmasters." https://scholar.google.de/intl/en/scholar/inclusion.html#indexing

Graham, K.E.R., H.L. Chorzempa, P.A. Valentine, & J. Magnan. "Evaluating Health Research Impact: Development and Implementation of the Alberta Innovates –

Health Solutions Impact Framework." *Research Evaluation* 2012; 21(5):354-67. doi: 10.1093/reseval/rvs027.

Halevi, G. "The Becker Medical Library Model for Assessment of Research Impact—An Interview with Cathy C. Sarli and Kristi L. Holmes." *Research Trends* 34 (2013, Sept.). http://www.researchtrends.com/issue-34-september-2013/the-becker-medical-library-model/

Haustein, S., T.D. Bowman, & R. Costas. "Interpreting 'Altmetrics': Viewing Acts on Social Media Through the Lens of Citation and Social Theories." In *Theories of Informetrics and Scholarly Communication. A Festschrift in Honor of Blaise Cronin*, edited by C. R. Sugimoto, 372–405. Berlin: De Gruyter, 2016. http://arxiv.org/abs/1502.05701

Haustein, S., T.D. Bowman, K. Holmberg, A. Tsou, C.R. Sugimoto, & V. Larivière. "Tweets as Impact Indicators: Examining the Implications of Automated "Bot" Accounts on Twitter. *Journal of the Association for Information Science and Technology* 67, no. 1 (2016): 232-238. http://dx.doi.org/10.1002/asi.23456

Haustein, S., T.D. Bowman, B. Macaluso, C.R. Sugimoto, & V. Larivière. "Measuring Twitter Activity of ArXiv E-prints and Published Papers." *Altmetrics14: Expanding Impacts and Metrics. An ACM Web Science Conference 2014 Workshop*. (2014). http://dx.doi.org/10.6084/m9.figshare.1041514

Haustein, S., R. Costas, & V. Larivière. "Characterizing Social Media Metrics of Scholarly Papers: The Effect of Document Properties and Collaboration Patterns: E0120495." *PLoS One* 10, no. 3 (2015). http://dx.doi.org/10.1371/journal.pone.0120495

Haustein, S., I. Peters, C.R. Sugimoto, M. Thelwall, & V. Larivière. "Tweeting Biomedicine: An Analysis of Tweets and Citations in the Biomedical Literature." *Journal of the Association for Information Science and Technology* 65, no. 4 (2013): 656–669. http://doi.org/10.1002/asi.23101. http://arxiv.org/abs/1308.1838

Haustein, S., C.R. Sugimoto, & V. Larivière. "Guest editorial: Social Media in Scholarly Communication." *Aslib Journal of Information Management* 67, no. 3 (2015). http://dx.doi.org/10.1108/AJIM-03-2015-0047

Holmberg, K. "The Impact of Retweeting." *Altmetrics14: Expanding Impacts and Metrics. An ACM Web Science Conference 2014 Workshop*. (2014). http://dx.doi.org/10.6084/m9.figshare.1037555

Identifiers.org. "Identifiers.org." (2016). http://identifiers.org/

Immonen, A., P. Paakkonen, & E. Ovaska. "Evaluating the quality of social media data in big data architecture." *IEEE Access* 3 (2015): 2028-2043. DOI: http://doi.org/10.1109/ACCESS.2015.2490723

Ingwersen, P. & V. Chavan. "Indicators for the Data Usage Index (DUI): An Incentive for Publishing Primary Biodiversity Data Through Global Information Infrastructure. BMC Bioinformatics 12 (Suppl 15), S3. (2011). http://doi.org/10.1186/1471-2105-12-S15-S3

The International Association for Information and Data Quality (IAIDQ). "Glossary," last updated July 19, 2015, from: http://iaidq.org/main/glossary.shtml

IRUS-UK. "Welcome to IRUS-UK." (2016). http://www.irus.mimas.ac.uk/

Jisc. "A Note About IRUSdataUK." (2016). https://rdmetrics.jiscinvolve.org/wp/2016/01/11/a-note-about-irusdatauk/

Kaur, J., M. JafariAsbagh, F. Radicchi, & F. Menczer. “Crowdsourced Disciplines and Universal Impact.” *Proc. ACM Web Science Altmetrics Workshop* (2014). http://dx.doi.org/10.6084/m9.figshare.1037741

Konkiel, S. “The Right Metrics for Generation Open: A Guide to Getting Credit for Open Science.” (October 24, 2014). http://blog.impactstory.org/right-metrics-generation-open-post/

Kraker, P., K. Jack, C. Schlögl, C. Trattner, & S. Lindstaedt. “Head Start: Improving Academic Literature Search with Overview Visualizations based on Readership Statistics.” WebSci13 (May 24, 2013). https://figshare.com/articles/Head_Start_Improving_Academic_Literature_Search_with_Overview_Visualizations_based_on_Readership_Statistics/696882

Lewison, G. “Beyond Outputs: New Measures of Biomedical Research Impact.” *Aslib Proceedings* 55, no. 1/2 (2003): 32-42. http://dx.doi.org/10.1108/00012530310462698

Lewison, G., G. Thornicroft, G. Szmukler, & M. Tansella. “Fair Assessment of the Merits of Psychiatric Research.” *British Journal of Psychiatry* 190 (2007, Apr.): 314-318. http://dx.doi.org/10.1192/bjp.bp.106.024919 (http://www.ncbi.nlm.nih.gov/pubmed/17401037)

Lin, J. “A Case Study in Anti-gaming Mechanisms for Altmetrics: PLos ALMs and Data Trust.” *Altmetrics12, SCM Web Science Conference 2012 Workshop*. (2012). http://altmetrics.org/altmetrics12/lin/

Lin, J. & M. Fenner. “An Analysis of Wikipedia References Across PLOS Publications.” (2014). https://figshare.com/articles/An_analysis_of_Wikipedia_references_across_PLOS_publications/1048991

Lupia, A. & C. Elman. “Openness in Political Science: Data Access and Research Transparency: Introduction.” *PS, Political Science & Politics* 47, no. 1 (2014): 19. http://dx.doi.org/10.1017/S1049096513001716

MacRoberts, M.H. & B.R. MacRoberts. “Problems of Citation Analysis: A Study of Uncited and Seldom-cited Influences.” Journal of the American Society for Information Science and Technology 61 (1), 1–12. (2010). http://doi.org/10.1002/(SICI)1097-4571(198909)40:5<342::AID-ASI7>3.0.CO;2-U

Manville C., S. Guthrie, M.-L. Henham, B. Garrod, S. Sousa, A. Kirtley, S. Castle-Clarke, & T. Ling. “Assessing impact submissions for REF2014: An evaluation.” Product Page. Santa Monica, CA: RAND Corporation, 2015 April 17. Report No.: RR-1032-HEFCE.

Massey University. “Research Management Services.” (2010). http://www.massey.ac.nz/massey/fms/Research_Management_Services/PBRF/PBRF%20Information%20-%20What%20Are%20Research%20Outputs.pdf

Mayernik, M.S. “Bridging Data Lifecycles : Tracking Data Use via Data Citations Workshop.” (2012). http://dx.doi.org/10.5065/D6PZ56TX

McKerlich, R., C. Ives, & R. McGreal. “Measuring Use and Creation of Open Educational Resources in Higher Education.” (2013). International Review of Research in Open and Distance Learning 14 (4), 90–103. http://www.irrodl.org/index.php/irrodl/article/view/1573/2637

Morgan Jones, M. & J. Grant. "Making the Grade: Methodologies for Assessing and Evidencing Research Impact." In: Dean A, Wykes M, Stevens H, editors. *7 Essays on Impact*. Exeter, UK: University of Exeter; 2013.

Moriano, P., E. Ferrara, A. Flammini, & F. Menczer, "Dissemination of Scholarly Literature in Social Media." (2014). http://dx.doi.org/10.6084/m9.figshare.1035127

Nason, E., L. Klautzer, & J. Rubin. *Policy and Practice Impacts of Research Funded by the Economic and Social Research Council. A Case Study of the Future of Work Programme, Supporting Data*. Cambridge, England: Rand Europe, 2007. http://www.esrc.ac.uk/files/research/evaluation-and-impact/case-study-future-of-work-programme-supporting-data/

National Information Standards Organization (NISO). SUSHI-Lite Technical Report Working Group. (2016). http://www.niso.org/workrooms/sushi/sushi_lite/

National Institute for Occupational Safety and Health. Filling the Knowledge Gaps for Safe Nanotechnology in the Workplace. (2013). http://www.cdc.gov/niosh/docs/2013-101/pdfs/2013-101.pdf

National Institutes of Health and the National Science Foundation. "STAR METRICS Research Institution Participation Guide." (2015). https://www.starmetrics.nih.gov/static-2-1-0/Content/Downloads/STAR-METRICS-Participation-Guide.pdf

Panel on Return on Investment in Health Research, 2009. *Making an Impact: A Preferred Framework and Indicators to Measure Returns on Investment in Health Research*. Canadian Academy of Health Sciences, Ottawa, ON, Canada. http://www.cahs-acss.ca/wp-content/uploads/2011/09/ROI_FullReport.pdf

Parsons, M. A., R. Duerr, & J. B. Minster. "Data Citation and Peer Review." Eos, Transactions American Geophysical Union, 91 (34), 297-298. (2010). http://doi.org/10.1029/2010EO340001

Patel, V.M., H. Ashrafian, K. Ahmed, S. Arora, S. Jiwan, J.K. Nicholson, A. Darzi, &T. Athanasiou. "How has Healthcare Research Performance Been Assessed? A Systematic Review. *Journal of the Royal Society of Medicine* 104, no. 6 (2011): 251-261. http://dx.doi.org/10.1258/jrsm.2011.110005

PLOS ALM. "ALM Workshop 2014 Report." *PLOS ALM* (2014). http://dx.doi.org/10.6084/m9.figshare.1287503

Priem, J., D. Taraborelli, P. Groth, & C. Neylon. "Altmetrics: A Manifesto." (2010). http://altmetrics.org/manifesto

Research Data Alliance. "RDA-WDS Publishing Data Interest Group Bibliometrics Working Group Case Statement." https://rd-alliance.org/sites/default/files/case_statement/RDA_WDS_WG_Publishing_Bibliometrics.pdf

Sarli, C.C., E.K. Dubinsky, & K.L. Holmes. "Beyond Citation Analysis: A Model for Assessment of Research Impact." *Journal of the American Medical Library Association* 98, no. 1 (2010):17-23. doi:10.3163/1536-5050.98.1.008. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2801963/

Sieber, J. E. & B. E. Trumbo. "(Not) Giving Credit Where Credit Is Due: Citation of Data Sets." Science and Engineering Ethics 1(1), 11–20. (1995). http://doi.org/10.1007/BF02628694

Starr, J., E. Castro, M. Crosas, M. Dumontier, R. R. Downs, R. Duerr…, T. Clark. Achieving Human and Machine Accessibility of Cited Data in Scholarly Publications. PeerJ Computer Science 1 (1). (2015). http://doi.org/10.7717/peerj-cs.1

Strasser, C., J.E. Kratz, & J. Lin. "Make Data Count - Unit 1 Final Report." (2015). Figshare. http://dx.doi.org/10.6084/m9.figshare.1328291

Thomson Reuters. "The Data Citation Index on Web of Science." (2016). http://wokinfo.com/products_tools/multidisciplinary/dci/

Thonon, F., R. Boulkedid, T. Delory, S. Rousseau, M. Saghatchian, W. van Harten, C. O'Neill, & C. Alberti. "Measuring the Outcome of Biomedical Research: A Systematic Literature Review." *PLOS ONE* 10, no. 4, e0122239 (2015). http://dx.doi.org/10.1371/journal.pone.0122239

The University of Auckland. "Research Outputs: Definition and Categories." (2013). https://www.auckland.ac.nz/en/about/the-university/how-university-works/policy-and-administration/research/output-system-and-reports/research-outputs--definition-and-categories.html

World Wide Web Consortium (W3C). "Data Catalog Vocabulary (DCAT): 5.3 Class: Dataset." (2014). https://www.w3.org/TR/vocab-dcat/#class-dataset

World Wide Web Consortium (W3C). "Dataset Descriptions: HCLS Community Profile." (W3C Interest Group Note 14 May 2015). https://www.w3.org/TR/hcls-dataset/

Wouters, P. & R. Costas. "Users, Narcissism and Control: Tracking the Impact of Scholarly Publications in the 21st Century." (2012). http://research-acumen.eu/wp-content/uploads/Users-narcissism-and-control.pdf

Zahedi, Z., M. Fenner, & R. Costas. "How Consistent are Altmetrics Providers? Study of 1000 PLOS ONE Publications using the PLOS ALM, Mendeley and Altmetric.com APIs. (2014): http://dx.doi.org/10.6084/m9.figshare.1041821

Zahedi, Z. & N.J. van Eck. "Visualizing Readership Activity of Mendeley Users Using VOSviewer." (2014): http://dx.doi.org/10.6084/m9.figshare.1041819