

Monitoring Open Science Implementation in Federal Science-based Departments and Agencies: Metrics and Indicators

Report of the Science-based Departments and Agencies (SBDAs) Open Science Metrics Working Group

Context

In its [Third Biennial Plan to the Open Government Partnership 2016-2018 \(OGAP3\)](#), the federal government committed to increase openness of its scientific activities by “[taking] appropriate steps to make the science performed in support of Government of Canada programs and decision-making open and transparent to Canadians”.¹ This objective is aligned with the adoption of the Directive on Open Government, Canada’s ‘open by default’ policy, which promotes information management practices that enable the proactive and ongoing release of government information.² More specifically, the OGAP3 commitment on Open Science focuses on six milestones, one of which is the development of metrics to “track collective federal progress on open science activities.”³ Annex 1 provides a glossary of common terms associated with open science.

In fulfillment of this commitment, this report presents a set of metrics that have been developed by the Open Science Metrics Working Group, which consist of representatives of the federal Science-based Departments and Agencies (SBDAs) (see Annex 2). These metrics have been designed for implementation starting in July 2018. They will also be used for reporting purposes annually beginning in June 2019. SBDAs have also identified the development of open science metrics as one of five priorities in the co-creation process of the Fourth Open Government Action Plan (OGAP4).

This framework applies to intramural research. It does not apply to the federal granting agencies⁴ in recognition of the specific challenges they faced in measuring open science activities

¹ Government of Canada (2016). Third Biennial Plan to the Open Government Partnership 2016-2018. URL: <https://open.canada.ca/en/content/third-biennial-plan-open-government-partnership>.

² Government of Canada (2017). Directive on Open Government. URL: <http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=28108>

³ Government of Canada (2016). Third Biennial Plan to the Open Government Partnership 2016-2018.

⁴ The federal granting agencies are the Social Science and Humanities Research Council (SSHRC), Canadian Institute of Health Research (CIHR), and the Natural Sciences and Engineering Research Council of Canada (NSERC).

conducted in funded academic research. However, the granting agencies have committed to work closely with other SBDAs and the Treasury Board Secretariat to align the monitoring processes, metrics, and indicators with the ones proposed here.

Open Science

In the public policy context, open science is generally understood as the efforts made to increase the accessibility of publicly funded research to the scientific community, the business sector, and society in general, using digital format.⁵ The concept of open science draws on both the tradition of openness in many scientific disciplines and the development of new information and communication technologies, which may be used to dramatically increase our capacity to access and utilizes scientific results.

For SBDAs, open science encompasses a vast array of activities, including providing access to peer-reviewed publications, the release of datasets, and public engagements involving federal scientists and science contributors.

One of the primary expected benefits of open science includes an increase in the effectiveness and productivity of scientific activities through the reduction of duplication in the collection, creation, transferring and reusing of data, and scientific material in general.⁶ There is also growing evidence that open access to peer-reviewed articles and datasets allows these to be repurposed by scientists, the public, and businesses to create innovative solutions, products, and services.⁷ Finally, open science promotes a greater scrutiny of scientific advice, allowing the verification of scientific results and a greater involvement of the public in science.⁸

Open Science Metrics

This report proposes a set of metrics and associated indicators to track open science activities of federal SBDAs. These metrics and indicators will provide a basis for the planning and assessment of SBDA progress in open science implementation. Moreover, the consistent implementation of cross-departmental metrics will facilitate collaboration and assist in the dissemination of best practices and innovations. The metrics presented here will be implemented starting July 2018, with the first reporting exercise to be concluded in June 2019, for the period

⁵ OECD (2015). *Making Open Science a Reality*. URL: <http://dx.doi.org/10.1787/23074957>.

⁶ OECD (2015). *Making Open Science a Reality*, p. 10.

⁷ OECD (2015). *Making Open Science a Reality*.

⁸ OECD (2015). *Making Open Science a Reality*, pp. 9-11.

covering January 1 to December 31, 2018. Meanwhile, SBDAs will continue to explore the development and the implementation of additional metrics.

A Flexible Approach to Open Science Metrics

Given that SBDAs have their own specific culture, mandate, and priorities, the Working Group members identified the need for a flexible approach for the development and implementation of open science metrics. The diversity in SBDA mandates implies varying capabilities and restrictions with regards to the potential for developing open science activities. For instance, some information generated by federal departments and agencies with regulatory mandates is not suitable for release because it is protected by the Privacy Act or deemed confidential for national security concerns.⁹

Moreover, the availability of new resources to expand current federal government open science capabilities is limited for all SBDAs. Members of the Open Science Metrics Working Group have identified additional resources and policy commitment as key factors that would allow more ambition in the monitoring of progress on open science.

While some federal organizations, such as Statistics Canada, have been sharing high-quality easy-to-use datasets for decades, other departments and agencies have engaged in these activities only recently. As open science practices vary between and within each organization and scientific discipline, some may face challenges with the timely publishing of information and data in ready-to-use formats. Other departments are concerned that although the release of individual datasets might seem benign, the aggregation of these datasets may lead to loss of context or unintended disclosure of sensitive information that could pose national security concerns. With the volume and complexity of data such as these, publication in ready-to-use formats represents a significant challenge. This reflects developing issues related to the use of ‘Big Data’, such as storage, access, and capacity to share.

Additionally, federal scientists and science contributors are using multiple repositories and portals to share their publications and datasets. Although such practice may assist in making scientific data available to Canadians, it can also render more complex the task of tracking federal datasets that have been released. Federal science contributors and scientists also share their research findings in a vast array of published materials, which include not only peer-reviewed journal articles but also books, chapters, reports, etc. While many databases are available to track peer-reviewed articles, tracking other types of publication has been identified as a challenge.

⁹ *Privacy Act* (R.S.C., 1985, c. P-21). URL: <http://laws-lois.justice.gc.ca/eng/acts/P-21/>

To advance the implementation of open science metrics while respecting the needs and challenges identified above, this report proposes a flexible approach that relies on both Core metrics, to be implemented by all SBDAs, and Supplementary metrics, to be implemented only by participating SBDAs on a trial basis. The last section of the report titled ‘Next Steps’ also mentions metrics that are currently under consideration for future implementation.

The selected metrics, below, offer opportunities for SBDAs to gather more information on the procedural aspects of open science. However, it is widely recognized in the SBDA community that the metrics will need to evolve to allow for the monitoring of open science outcomes, such as the benefits of federal open science activities to Canadians.

Selected Open Science Metrics

The metrics introduced here are meant to facilitate reporting on open science activities while acknowledging the variety of challenges faced by departments and agencies in monitoring their progress. This document presents the metrics and indicators recommended for implementation. However, the complexity of measuring some indicators associated with these metrics, coupled with the need for consistency across SBDAs, suggested a need for additional information about their implementation including definitions and methods for data collection. To that end, the annexes of this report contain four schemas, one for each core metric, which describe the measurement methodology and provide a uniform framework for reporting (see Annexes 3 to 6). While two of these metrics require more detailed schemas, Open Access publications and Open Science public engagements metrics (see Table 1 and Annexes 3 and 4),¹⁰ the two other metrics, Open Government Datasets and Open Maps, are fairly straightforward to implement and require only a short schema (see Annexes 5 and 6).

Defining Open Science Metrics

While core metrics are designed to measure progress of open science activities that are conducted in all SBDAs, supplementary (optional) metrics will monitor open science initiatives that may not be common to all SBDAs and are thus reported only by some departments and agencies. In comparison, the core metrics are expected to be reported on by all SBDAs in a consistent manner way to allow for aggregation at the federal level. These metrics are

¹⁰ To prepare the detailed methodology schemas, the Working Group was able on several existing studies commissioned by the SBDAs, including: Science-Metrix (2017). Bibliometric assessment of Open Access for Environment and Climate Change Canada, Methods Report; Science-Metrix (2018). Bibliometric assessment of Open Access for Environment and Climate Change Canada; NIVA Inc. (2016a). Open Science Engagement, Volume 1: A Federal Inventory and Analysis; and, NIVA Inc. (2016b). Open Science Engagement, Volume 2: International Environmental Scan: <https://gcconnex.gc.ca/file/download/24869440>

summarized in Table 1 and are described in greater detail in the metric-specific schemas in annex to this report. A variety of indicators are proposed for monitoring core and supplementary metrics, enabling SBDA to measure trends over time and to demonstrate progress with respect to implementing Open Science.

One of the objectives of proposing the supplementary metrics is to encourage SBDA to experiment with and gain experience in the development of metrics that could be considered for inclusion as core metrics in the future. These metrics are summarized in Table 2. However, information about these metrics is not supplemented in metric-specific schemas. This will allow SBDA to experiment with different methodologies to implement them, which could offer insights into the comparative effectiveness and efficiency of different monitoring mechanisms.

Defining Indicators

An indicator is generally understood as “a quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect changes connected to an intervention, or to help assess the performance of (an) actor”.¹¹ For example, the metric “open science publications” is measured using, among other indicators, the percentage of peer-reviewed articles that are available in open access for each SBDA (see Table 1).

Quantitative indicators for open science metrics, much like other government performance indicators, are composed of a number and a unit. While the number indicates the magnitude (answering the question: how much?), the unit gives the number its meaning (answering the question: what?).¹²

Qualitative indicators are sometime expressed in ‘expository form’ including assessment of research quality and rating scale.¹³ In the context of this report however, the expression ‘qualitative indicator’ designates indicator for which information has been gathered through the use of qualitative research methods that include inventories, classification of activities through the application of descriptive typologies, and cases studies. These methods are used to provide information about open science activities for which quantitative indicators are not available at this time or do not provide sufficient details.

¹¹ OECD (2002). *Glossary of Key Terms in Evaluation and Results Based Management*. URL: <http://www.oecd.org/development/peer-reviews/2754804.pdf>

¹² Treasury Board Secretariat (2010). *Supporting Effective Evaluations: A Guide to Developing Performance Measurement Strategies*. URL: <https://www.canada.ca/en/treasury-board-secretariat/services/audit-evaluation/centre-excellence-evaluation/guide-developing-performance-measurement-strategies.html>

¹³ Treasury Board Secretariat (2010). *Supporting Effective Evaluations: A Guide to Developing Performance Measurement Strategies*.

Depending on the open science activities observed, qualitative, quantitative, or a mix of both types of indicators, can be used to tell the SBDAs story in relation to a given metric. Table 1 presents a list of the initial Core metrics and indicators that have been selected for implementation starting in July 2018. Table 2 presents the list of Supplementary metrics and their indicators for which at least one department or agency has indicated that they are in a position to report or will be in June 2019.

Table 1. Selected Core Metrics for Implementation starting July 2018 and their indicator(s)¹⁴

Metric	Indicator	Type	Data source	Baseline data	Observation period
Open access Publications (detailed schema)	1. Percentage of peer-reviewed articles that are available in open access per Science-Based Departments and Agency (SBDA). Requires the following to be measured: <ul style="list-style-type: none"> ○ Number of open access peer-reviewed articles per SBDA.¹⁵ <ul style="list-style-type: none"> ▪ Number of open access peer-reviewed articles per SBDA provided by the publisher. ▪ Number of open access peer-reviewed articles per SBDA not provided by the publisher.¹⁶ ○ Total number of published peer-reviewed articles per SBDA. 	Quantitative	External contract with bibliometrics provider -Internal SBDA tracking system.	ECCC-Science Metrix Study (2012-15) for 14 SBDA's.	Previous years (2016-17)
Open science Public Engagement (detailed schema)	2. Inventory of open science public engagement activities involving members of the public and federal scientists and science contributors.	Qualitative	Internal SBDA tracking system.	NIVA report	Current (2018)
Open science data	3. Percentage of releasable/eligible SBDA datasets identified in the open data inventory that have been released. ¹⁷ Requires the following to be measured: <ul style="list-style-type: none"> ○ Number of releasable/eligible SBDA datasets identified in the open data inventory that have been released. ○ Number of SBDA datasets identified in the open data inventory. 	Quantitative	Open data inventory	Open data inventory	Current (2018)
Other open science products	4. Inventory of SBDA datasets available through Open Maps.	Qualitative	-Open Government Portal (Open Maps)	-Open Government Portal (Open Maps). ¹⁸	Current (2018)

Notes: All indicators will be implemented on a yearly basis (using a calendar year). Data collected will be used for the purpose of reporting in various venues, including the Open Government Action Plan. Metrics subjected to detailed schemas are those requiring further explanations due to their higher level of complexity.

¹⁴ See glossary in Annex 1 for detail on terminology. See schemas in Annexes 3-6 for a detailed methodology for each indicator.

¹⁵ This includes all publications for which at least one of the authors identified a SBDA or a component (e.g. a research lab) of that SBDA as her/his affiliation.

¹⁶ This includes, but is not limited to, self-archived open access provided by the author through the institutional repository.

¹⁷ This metric is already included in the Progress tracker for the Third Biennial Plan to the Open Government Partnership, under “Commitment 14: Increase openness of federal science activities (open science)” with a target of 20% by June 2018. URL: <https://open.canada.ca/en/commitment-14-increase-openness-federal-science-activities-open-science>.

¹⁸ As of April 24, 2018: 729 open maps from 8 SBDA's.

Table 2. Selected Supplementary Metrics for Implementation in July 2018 and their indicator(s)

Metric	Indicator(s)	Type	Data source	Observation period
Open science data	<p>1. Inventory of SBDA open access datasets provided through portals or repositories, other than Open Maps and the Open Government Portal.</p> <p><i>Requires the following information:</i></p> <ul style="list-style-type: none"> ○ Inventory of SBDA open access datasets provided through Federal repository or portal, with the exception of datasets provided through Open Maps and the Open Government Portal. ○ Inventory of SBDA open access datasets provided through third party portals or repositories.¹⁹ <p>2. Inventory of portals or repositories used by SBDAs to provide open access datasets, other than Open Maps and the Open Government Portal.</p> <p><i>Requires the following information:</i></p> <ul style="list-style-type: none"> ○ Inventory of federal portals or repositories used by SBDAs to provide open access datasets, other than Open Maps and the Open Government Portal. ○ Inventory of third party portals or repositories used by SBDAs to provide open access datasets. 	Qualitative	SBDAs pilot for internal monitoring	Current (2018)
Open science engagement	<p>3. Altmetrics for selected publications.</p> <p><i>Requires the following to be measured:</i></p> <ul style="list-style-type: none"> ○ Altmetric Attention Score (customized) for selected publication.²⁰ 	Qualitative	SBDAs pilot for internal monitoring	Current (2018)
Other open science products	4. List and descriptions of open science related software.	Qualitative	SBDAs pilot for internal monitoring	Current (2018)

¹⁹ Third party is defined here as an organization not under the purview of the Federal governments allowing federal SBDAs to benefit from their portals or repositories. It could include, for instance repositories controlled by provincial/territorial/municipal governments, universities, foreign governments and their agencies, non-profit organizations, international organizations, etc.

²⁰ While the Altmetric Attention Score represents a weighted count of all of the attention a research output has received, and can be automatically calculated for federal science publications, it can also be customized to fit the needs of specific organizations. In the case of the SBDAs, this would involve, for instance, focusing on policy papers containing references to federal science research rather than other sources (e.g. blogs). It can also be used as a qualitative indicator to showcase specific examples of innovation driven by federal science research.

Next Steps

The immediate next step is the implementation of the agreed upon metrics by SBDAs. For that purpose, SBDAs will need to prepare an implementation plan for the open science metrics, providing timelines for data collection and reporting. While details of the implementation plan are forthcoming, the proposed date for the publication of the open science metric baseline data and results is set for June 2019, for an observation period covering January 1 to December 31, 2018. Another important task is to identify open science stakeholders and end-users and engage with them on the further development of open science metrics.

Through their continuous involvement in the Fourth Open Government Action Plan (OGAP4) 2018-2020, SBDAs will explore the development of new metrics and indicators for open science. The activities targeted by these new metrics could include:

- The publication of datasets linked with open access peer-reviewed publications;
- Inventories of scientific datasets distinct from open dataset inventories;
- Internal and external policies to encourage open science; and
- Use of unique researcher identifiers (e.g. ORCID).

Moreover, future open science metrics will be developed to assess open science outcomes such as impact and benefits to Canadians. Altmetrics have already been identified as an optional indicator, which will allow for tracking of the diffusion of federal research finding in social medial. In addition to that, new metrics to measure the impact of federal open science could include:

- Case studies of innovations driven by federal open access publications and datasets.
- Inventory of new stories about federal open science public engagements;
- Citations of federal open access publications and datasets in patents.
- Citations of federal open access publications in academic research, papers, etc.;
- Citations of federal open access datasets; and
- Citations of federal open access publications and datasets in governmental reports, regulatory analysis, consultation documents, etc.
- Citations of federal open access publications and datasets in regulation, legislation, action plans, and other policy intervention documents.

Annex 1: Glossary

Altmetrics: alternative way of recording and measuring the use and impact of scholarly outputs. Rather than solely counting the number of times a work is cited in scholarly literature, altmetrics measures and analyzes on-line mentions of scholarly outputs in various sources, from media, to policy type documents, patents, social media (e.g., Facebook, Twitter, etc.), blogs, document downloads, links to publishing and unpublished research, and other uses of research literature, in order to provide a more comprehensive measurement of reach and impact.²¹

Altmetric Attention Score (from Altmetrics.com): a weighted count of the attention a research output has received,²² which can be customized to fit the needs of specific organizations.

Indicator: Quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance of an actor.²³

Open Access: in the context of scientific publication is defined as the action of making peer-reviewed scholarly manuscripts and other publications freely available via the Internet, permitting any user to read, download, copy, distribute, print, search, or link to the full text of these articles, crawl them for indexing, pass them as data to software, or use them for any lawful purpose, without financial, legal or technical barriers other than those inseparable from gaining access to the Internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited. There are several types of open access publications (Gold, Green, Hybrid, and Bronze Open Access). For the purpose of implementing metric, a distinction is made only between Open Access articles provided by the publisher — open access on the publisher’s website—and Open Access provided by other sources than the publisher—e.g. self-archived articles that can be accessed through institutional repositories.²⁴

Open Science: efforts made to increase the accessibility of publicly funded research to the scientific community, the business sector, and society in general, using digital format. Open Science represents a union of the tradition of openness in science with information and communications technologies.²⁵

²¹ Altmetric. 2018. What are Altmetrics? Capturing the online attention surrounding scholarly content. URL: <https://www.altmetric.com/about-altmetrics/what-are-altmetrics/>

²² Altmetric. 2018. The donut and Altmetric Attention Score. URL: <https://www.altmetric.com/about-our-data/the-donut-and-score/>

²³ OECD (2002). Glossary of Key Terms in Evaluation and Results Based Management.

²⁴ Adapted from: Science-Metrix (2017). Bibliometric assessment of Open Access for Environment and Climate Change Canada, Methods Report.

²⁵ OECD (2015). Making Open Science a Reality.

Public engagements: the contributions and collaborations undertaken by various people and groups in society—from lay persons to science experts—who are engaged in open science processes that range from early policy development to the delivery of science activities. Public engagement include: 1) participation of the public with scientists, the public makes contributions to science (a two-way communication scenario), 2) communication and outreach activities (a one-way communication from scientists to the public); 3) public consultation (a one-way communication from the public to scientists).²⁶

Quantitative indicators: indicators composed of a number and a unit. While the number indicates the magnitude (how much), the unit gives the number its meaning (what).²⁷

Qualitative indicators: indicators for which information has been gathered through the use of qualitative research methods that include inventories, activities' classification through the application of descriptive typologies, and cases studies. These methods are used to provide information about Open Science activities for which quantitative indicators are not available at this time or do not provide sufficient details.

Repository (institutional): An online database designed to collect the intellectual output of a particular institution or university, including digital collections such as electronic theses and dissertations, pre-prints, or faculty scholarship, and presents associated metadata regarding these items.²⁸

Science contributor: An employee of the Government of Canada whose primarily affiliation is with a federal SBDA and who take some part in scientific activities without producing the science (communications, I.M. and I.T., research, etc.).

Scientists: An employee of the Government of Canada whose primarily affiliation is with a federal SBDA and who participates in scientific research as a primary duty.

Scientific datasets: In the context of this report, scientific datasets refer to those which can be used for public engagement. This includes scientific datasets deemed important in order to understand or reproduce the scientific process presented in a peer-reviewed article, those collected in the context of monitoring or regulatory programs and relevant statistics.

²⁶ NIVA Inc. (2016). Open Science Engagement, Volume 1: A Federal Inventory and Analysis.

²⁷ Treasury Board Secretariat (2010). *Supporting Effective Evaluations: A Guide to Developing Performance Measurement Strategies*. URL: <https://www.canada.ca/en/treasury-board-secretariat/services/audit-evaluation/centre-excellence-evaluation/guide-developing-performance-measurement-strategies.html>

²⁸ University of Pittsburg Library System (2018). Glossary. URL: <http://www.righttoresearch.org/resources/openresearchglossary/>

Annex 2 – Members of the SBDA's Open Science Metrics Working Group

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Annex 3 - Schema for Open Access Publications – metric and indicators

Field	Field Description
Name	Open Access Publications
Can apply to (unit of analysis)	Individual peer-reviewed publications (i.e., journal articles).
Metric and indicators definition	<p>This metric aims to measure the number and proportion of Open Access (OA) peer-reviewed articles produced by Science-based Departments and Agencies (SBDAs) (see Glossary, in Annex 1, for definition)</p> <p>For the purpose of the Open Science Metrics reporting, the following indicators will be considered for interdepartmental comparability:</p> <ol style="list-style-type: none"> 1. Percentage of peer-reviewed articles that are available in Open Access per Science-Based Departments and Agency (SBDA). Requires the following to be measured: <ul style="list-style-type: none"> ○ Number of open access peer-reviewed articles per SBDA.²⁹ <ul style="list-style-type: none"> ▪ Number of open access peer-reviewed articles per SBDA provided by the publisher. ▪ Number of open access peer-reviewed articles per SBDA not provided by the publisher.³⁰ 2. Total number of published peer-reviewed articles per SBDA.³¹ <p>The counting of a publication in the self-archived or publisher website category will be done at the time at which the list is created for reporting purposes (i.e., it will not address delayed open access or green open access where a publication is still under embargo).</p>
Metric calculation	<p>The metric is quantitative. SBDAs will produce a list of peer-reviewed publications where at least one author is an employee of the SBDA. This list will be used to generate both numbers of OA publications and a percentage of OA publications produced by the SBDAs.</p> <p>SBDAs should consider that their organization likely has multiple affiliations used by their authors, and format search queries of publication databases accordingly.</p>

²⁹ This includes all publications for which at least one of the authors identified a SBDA or a component (e.g. a research lab) of that SBDA as her/his affiliation.

³⁰ This includes, but is not limited to, self-archived open access provided by the author through the institutional repository.

³¹ To calculate the number of Open Access publications, Departments should take the total number of publications minus the number of restricted access publications. The number of Open Access publications cannot be ascertained by simply adding the self-archived and publisher provided OA publications together as some publications can be both at the same time, provided by the publisher and self-archived by authors, and thus would be counted twice.

Field	Field Description
Data sources	<p>Publication lists can be acquired from various sources, including:</p> <ul style="list-style-type: none"> ● Canadian federal science repository ● Scopus ● Web of Science ● External contract with bibliometrics provider ● SBDAs' internal publication tracking databases <p>The Open Access status of the publications can be acquired from various sources, including:</p> <ul style="list-style-type: none"> ● IScience ● Web of Science ● Unpaywall ● SBDAs' internal publication tracking databases ● Scopus <p>Through the Open Science Metrics Working Group, SBDAs will be encouraged to coordinate their efforts to ensure that sources of information on open access publications are exhaustive and consistent. This could be done through a common contract with a bibliometric provider.</p>
Appropriate use cases	<p>This metric is meant to observe the quantity and proportion of peer-reviewed publications departments and agencies are publishing in Open Access, and what type of Open Access is being utilized (self-archived or provided through the publisher website).</p>
Limitations	<ul style="list-style-type: none"> ● Data set delineation: Rates of OA are typically notably lower for the two (2) years just prior to the time of measurement. This is known as the embargo effect; many publishers will not allow papers to be published in OA until an embargo period has elapsed, during which time the publishers themselves retain the exclusive right to distribution. After the embargo period has passed, typically no longer than 24 months, papers can then be legally posted online. For this reason, OA measurements for the most recent years will be unreflective of stable, longer-term findings.³² ● Some publications are tagged to Green and publisher website OA categories at the same time. ● Copyright needs to be respected and the copyright permission for repository use can differ depending on the publisher, agreements between the institution and publisher, etc. ● Comparison between departments and agencies should be made with caution and, at the very least, should use proportion of OA articles rather than absolute number, to take into consideration that department varies, for instance, in the number of scientists they employ.

³² Archambault, É. et al. (2014). *Evolution of open access policies and availability, 1996–2013*. RTD-B6-PP-2011-2: Study to develop a set of indicators to measure open access. Montréal, Canada: Prepared for the European Commission. Retrieved from http://science-metrix.com/files/science-metrix/publications/d_4.5_sm_ec_dg-rtd_oa_policies_proportion_oa_1996-2013_v05p_0.pdf.

Field	Field Description
Inappropriate use cases	In measuring this metric, SBDAs have to be wary of mistakenly collecting data on unrelated items such as conference abstracts or internal reports, for example.
Available sources for baseline data	Baseline data for 14 SBDAs is available in an Environment and Climate Change Canada (ECCC) - Science Metrix study that covers 2012-15 publications (Figure 2).
Transparency	Since this indicator is related to the number and percentage of Open Access peer-reviewed publications, a list of publications needs to be available in a comprehensive, ready-to-share format. This publication list should include a tagging of the publications that are available in Open Access, the type of OA at the time of the list's creation, and a DOI to locate the publication online. Refer to Figure 1.
Website	Scopus: https://www.elsevier.com/solutions/scopus Web of Science (Clarivate Analytics): https://clarivate.com/products/web-of-science/ 1Science: https://1science.com/ Unpaywall API or the Simple Query Tool: http://unpaywall.org/
Timeframe	<p>The observation period covers two consecutive years that have occurred one year before the reporting year.</p> <p>For instance, observations for the period from January 1, 2016 to December 31, 2017, will be reported in the year 2018.</p> <p>This is meant to take into consideration journal embargos and delayed open access, minimizing the under-reporting of Open Access publications while providing relatively timely observations.</p> <p>Nonetheless, given the variance in embargo period for publications, revised figure will need to be provided in subsequent reporting periods.</p>
References	<p>Science-Metrix (2018). Bibliometric assessment of Open Access for Environment and Climate Change Canada.</p> <p>Science-Metrix (2017). Bibliometric assessment of Open Access for Environment and Climate Change Canada, Methods Report.</p>

Table A1. Sample Open Access publication tracking table.

Publication year (from the citation)	Citation (include DOI)	Open access status – open or restricted	Open Access - self-archived or publisher website	Government of Canada Department or Agency	Date OA status assessed (as it can change over time)
2017	Spoelstra, J., Senger, N.D., and Schiff, S.L. (2017) Artificial sweeteners reveal septic system effluent in rural groundwater. <i>Journal of Environmental Quality</i> 46: 1434-1443. 10.2134/jeq2017.06.0233	Open	Self-archived	ECCC	December 2017
2017	Howell, S.E.L., Komarov, A.S., Dabboor, M., Montpetit, B., Brady, M., Scharien, R.K., Mahmud, M.S., Nandan, V., Geldzetsler, T., and Yackel, J.J. (2017) Comparing L- and C-band synthetic aperture radar estimates of sea ice motion over different ice regimes. <i>Remote Sensing of Environment</i> 204: 380-391. 10.1016/j.rse.2017.10.017	Restricted	N/A	ECCC	April 2018
2017	Crouse, D.L., Pinault, L., Balram, A., Hystad, P., Peters, P.A., van Donkelaar, A., Martin, R.V., Ménard, R., Robichaud, A., and Villeneuve, P.J. (2017) Urban greenness and mortality in Canada's largest cities: A national cohort study. <i>Lancet Planet Earth</i> , vol. 1, October 2017, e289. 10.1016/S2542-5196(17)30118-3	Open	publisher provided	ECCC	December 2017

Baseline Data

A benchmark study was contracted by ECCC using the bibliometrics company Science-Metrix. The study aimed to look at how many peer-reviewed publications were produced by each organization over the study period of 2012 to 2015. Table A2 summarizes the results of the study.

Table A2. Publication output for 2012-2015 for the world, Canada and in 14 Canadian Science-Based Departments and Agencies (Science-Metrix 2018).

Area/Organisation	Output (2012-2015)				
	All pubs.	Restricted access	Total OA	Gold OA	Green OA
World	5,826,333	2,858,572	2,967,761	1,285,953	1,967,900
Canada	259,007	116,372	142,635	62,564	95,352
Federal family	17,695	7,569	10,126	3,964	7,292
AAFC	4,056	1,958	2,098	786	1,588
NRC Canada	3,483	1,621	2,222	991	1,519
ECCC	2,835	1,010	1,825	522	1,389
NRCan	2,549	1,209	1,340	351	980
DFO	1,768	563	1,205	370	896
PHAC	1,171	348	823	634	533
HC	945	421	524	318	342
DRDC	436	242	194	63	134
AECL	404	218	186	40	147
CFIA	361	151	210	121	147
ISED	190	149	41	27	21
Parks Canada	129	53	76	20	57
CSA	95	48	46	16	41
TC	11	5	6	1	3

The study, Science-Metrix (2018) used two databases, crosslinked to produce bibliometric indicators on articles identified as available in open access. The bibliometric indicators were computed using data from the Web of Science; the open access availability of articles was measured using the database that to date is the most comprehensive at indexing articles available in OA: the 1science database. A feature that motivated the selection of the WoS for this study was that the 1science database has a better alignment with the WoS than it does with Scopus (the major competitor of the WoS) within the normal workflow of Science-Metrix.

The database produced by 1science (the sister company of Science-Metrix) is a bibliographic database containing records for 28.3 million research articles available in OA published since the year 2000 across more than 30,000 peer-reviewed journals, as well as considerable volumes of older material. These records include a URL hyperlink to scholarly content that is available for free and without encumbrance (i.e., website registration, password entry, CAPTCHAs, and other impediments). Based on these hyperlinks, items in the database are tagged as *publisher website OA* or *green OA* (provided by the author or their institution, or some other party), although tagging is not exhaustive because some web domains remain to be characterized, aggregated into an *unknown OA* category (Science-Metrix, 2018).

For this study, ‘full counting’ was employed. In this, each country or research organization that has a researcher on the list of authors for a given paper gets a full count (1 publication) for that paper. For example, if a paper is authored by two researchers with addresses in the UK, one from Spain and one from Canada, the paper will be counted once for the UK, once for Spain and once for Canada (Science-Metrix, 2018).

Annex 4 - Schema for Open Science Public Engagement

Field	Field Description
Name	Open Science Public Engagement
Can apply to (unit of analysis)	Individual items (events, communication products, consultations, etc.). See the data section.
Metric and indicators definition	<p>This metric aims at observing Open Science Public Engagement events conducted by Science-based Departments and Agencies (SBDAs) for each calendar year starting on January 1, 2017 (see glossary in Annex 1 for definition).</p> <p>For the purpose of Open Science Metrics at the federal government, three types of public engagements should be considered:</p> <ol style="list-style-type: none"> 1) Public participation: opportunities to foster mutual exchanges between scientists and the public to make contributions to science (two-way flow).³³ 2) Communication and outreach: activities conducted by scientists to inform the public (one-way flow: from scientists to the public) 3) Public consultation: activities involving one-way communication from the public to scientists (one way flow: from public to scientists). <p>These definitions are adapted from NIVA Inc. (2016A) report on SBDAs public engagement activities the specifically. They were designed to match the reality of public engagement activities in science at the federal government. The NIVA Inc report provides an inventory of SBDAs public engagement activities which can be used as baseline data for implementing the metric.</p>
Metric calculation	To better represent different levels of capacity in SBDAs, the metric is qualitative. It is focused on describing provided examples rather than counting up numbers of activities. Each SBDA will produce a list (or inventory) of public engagement activities, according to the three aforementioned types of public engagement using the table provided in Schedule 2. The list does not necessarily need to be exhaustive. Reporting will be conducted on two consecutive years, starting with 2016-2017

³³ NIVA Inc., March 2016A. Open Science Engagement, Volume 1: A Federal Inventory and Analysis, p.9

Field	Field Description
Data sources	<p><i>Items (or activities which can be added to the inventory):</i> consultations processes; crowdsourcing initiatives; data gathering, processing and analyzing involving the public; informative videos, conferences; other communication products relevant to science; outreach events from scientists to the public.</p> <p><i>Sources for gathering data:</i> department annual reports, departmental communications team; departmental websites (gc.ca, social medias, etc.); employee surveys; news scans.</p> <p>A template will be provided.</p>
Appropriate use cases	<p>This metric is meant to provide an overview of different means by which departments and agencies are seeking public participation in SBDA scientific activities, without being necessarily exhaustive. It provides an opportunity for SBDAs to present selected exemplary public engagement activities of different types. This metric was designed to promote capacity building in monitoring public engagement activities and provide detailed examples of SBDAs best practices to help tell the story of Open Science at the federal government and inspire future SBDA initiatives.</p>
Limitations	<p>Appropriate use of the metric may be difficult to differentiate from inappropriate use, as the actual subject and content of the measured items may be difficult to assess.</p> <p>Likewise, the impact of monitored activities may vary greatly, ranging from significant to no impact (e.g.: a consultation could have taken place without any participant taking part in it).</p> <p>Measurable items do not apply to every SBDA.</p> <p>The typology of public engagement initiatives used here is based on an inventory of international initiatives, which was then applied to activities conducted by federal SBDAs.</p> <p>However, not all SBDA participated to this exercise and it very likely that some public engagement activities may not have been included. Therefore, this metric should be understood as a work in progress and activities that are understood as public engagement while not included in the examples provided for the inventory should be noted and considered for inclusion in the future.</p> <p>Considering their different realities, comparing the performance of SBDAs on public engagement was deemed counterproductive. Rather, this metric allows SBDAs to report on their best practices. SBDAs can therefore choose how many and which examples they wish to report on this metric.</p>

Field	Field Description
Inappropriate use cases	In measuring this metric, SBDA's have to be wary of mistakenly collecting data on items unrelated to public engagements. For instance, the participation of federal scientists in academic conferences (where scientists speak to an audience of experts) would not count as public engagement.
Available sources for baseline data	NIVA Inc., March 2016A. Open Science Engagement, Volume 1: A Federal Inventory and Analysis. Government of Canada. URL: https://gconnex.gc.ca/file/download/24869440 .
Transparency	Since this indicator focuses on public engagement activities, internal assessments on a department's public engagement activities would need to be inventoried in a comprehensive ready-to-share format to support accountability and information requests. This includes an inventory of the collected data with links to where items (events, communications products, conferences, etc.) are kept or mentioned on the Internet.
Timeframe for reporting	Every calendar year, starting on January 1, 2018.
References	Health Canada, March 2018. Development of A Framework for Conceptualizing and Measuring "Citizen Engagement" in Science at Health Canada using Empirical Evidence NIVA Inc., March 2016A. Open Science Engagement, Volume 1: A Federal Inventory and Analysis. https://gconnex.gc.ca/file/download/24869440 . NIVA Inc., March 2016B. Open Science Engagement, Volume 2: International Environmental Scan: https://gconnex.gc.ca/file/download/24869440

Annex 5 - Schema for Open Science Data

Field	Field Description
Name	Open Science Data
Can apply to (unit of analysis)	Open access datasets identified in the open data inventory (https://open.canada.ca/en/search/inventory)
Metric and indicators definition	<p>This metric aims at measuring the number and proportion of eligible datasets released to the public by the Science-based Departments and Agencies (SBDAs).</p> <p>The current indicator selected is designed to match the one identified by the Treasury Board Secretariat in their <i>Progress tracker for the Third Biennial Plan to the Open Government Partnership</i>, relating to Commitment 14 of the Third Plan: <i>Increase openness of federal science activities (open science)</i>.</p> <p>SBDAs will extract their list of datasets from the open data inventory which differentiate between datasets that are already made available to the public, datasets that are eligible for Open Access but that are yet to be released, and datasets that are not releasable to the public.</p> <p>The main indicator selected for this metric can be measured through two sub-indicators.</p> <p>Main indicator: Percentage of releasable/eligible SBDA datasets identified in the open data inventory that have been released.</p> <p>Requires the following to be measured:</p> <ul style="list-style-type: none"> ○ Number of releasable/eligible SBDA datasets identified in the open data inventory that have been released. ○ Number of SBDA datasets identified in the open data inventory.
Metric calculation	The metric is quantitative.
Data sources	The list of datasets will be obtained through the open data inventory.
Appropriate use cases	This metric provides information about eligible datasets released by Science-based Departments and Agencies.
Limitations	While many of these datasets have or could be used for science and have been generated by federal scientists, it is not the case for all datasets.
Inappropriate use cases	This indicator should be understood as a measure of datasets released by Science-based Departments and Agencies, which includes but is not restricted to datasets used for scientific activities.
Available sources for baseline data	Baseline data is available through the Open data inventory.
Transparency	Information gathered by SBDAs would need to be inventoried in a comprehensive, ready-to-share format to support accountability and information requests.
Timeframe	Every calendar year, starting on January 1, 2018.

Field	Field Description
References	Progress tracker for the Third Biennial Plan to the Open Government Partnership, Commitment 14 of the Third Plan: Increase openness of federal science activities (open science). URL: https://open.canada.ca/en/commitment-14-increase-openness-federal-science-activities-open-science

Table A3. Sample Open Science Data tracking table presenting a Statistic Canada example retrieved from the open data inventory.

Dataset title	Data holder (branch, division, team, individual)	Made available to the public	Not made available but eligible for Open Access	Not eligible for Open Access
Water use parameters in manufacturing industries, by provinces, territories and drainage regions	ECCC	Yes		

Annex 6 - Schema for Other Open Science Products

Field	Field Description
Name	Other Open Science Data Products
Can apply to (unit of analysis)	SBDA datasets available through Open Maps
Metric and indicators definition	This metric aims at providing examples of SBDA datasets made available through Open Maps, an application of the Federal Geospatial Platform providing geospatial visualizations of data to the public.
Metric calculation	The metric is qualitative. Each SBDA will produce a list (or inventory) of datasets made available through Open Maps, providing the name of the dataset, a description, and a link to the dataset.
Data sources	The Open Maps application on the Open Government Portal: https://open.canada.ca/data/en/dataset?collection=fgp&q
Appropriate use cases	This metric is meant to provide an overview of datasets made available through Open Maps by SBDAs, without being necessarily exhaustive. It provides an opportunity for SBDAs to present examples of datasets available on Open Maps which relate to their activities. This will help tell the story of Open Science at the federal government and inspire future SBDA initiatives.
Limitations	Considering their different realities, comparing the performance of SBDAs on this metric was deemed counterproductive. Rather, this metric allows SBDAs to report on their best practices. SBDAs can therefore choose how many and which examples they wish to report on this metric.
Inappropriate use cases	This metric was not designed for the purpose of comparing between SBDAs but to provide examples of datasets shared through Open Maps.
Available sources for baseline data	Open Government Portal (Open Maps). As of April 24, 2018: 729 open maps from 8 SBDAs.
Transparency	Information gathered by SBDAs would need to be inventoried in a comprehensive, ready-to-share format to support accountability and information requests.
Timeframe for reporting	Every calendar year, starting on January 1, 2018.
References	The Open Maps application of the Open Government Portal: https://open.canada.ca/data/en/dataset?collection=fgp&q

Table A4. Sample of Other Open Science Products table presenting an example retrieved from Open Maps.

DFO		
Name of dataset	Description	URL
Oceans Act Marine Protected Areas	<p>Marine protected areas (MPA) are one among a number of spatial management tools that contribute to the improved health, integrity and productivity of our marine ecosystems and help advance integrated ocean management. As planning Canada's marine protected area network moves forward, the locations of future Oceans Act Marine Protected Areas will be selected based on a systematic and collaborative approach described in the National Framework for Canada's Network of Marine Protected Areas (2011). Currently, Fisheries and Oceans Canada has a number of Marine Protected Areas designated under the Oceans Act and Areas of Interest for new Marine Protected Areas at various stages of progress towards designation. These areas are ecologically significant, with species and/or properties that require special management consideration. An Oceans Act Marine Protected Area (http://www.dfo-mpo.gc.ca/oceans/index-eng.html) is an area of the sea that forms part of the internal waters of Canada, the territorial sea of Canada or the exclusive economic zone of Canada designated for the conservation and protection of:</p> <ul style="list-style-type: none"> - commercial and non-commercial fishery resources, including marine mammals, and their habitats; - endangered or threatened marine species, and their habitats; - unique habitats; - marine areas of high biodiversity or biological productivity; and - any other marine resource or habitat as is necessary to fulfill the mandate of the Minister. 	https://open.canada.ca/data/en/dataset/a1e18963-25dd-4219-a33f-1a38c4971250