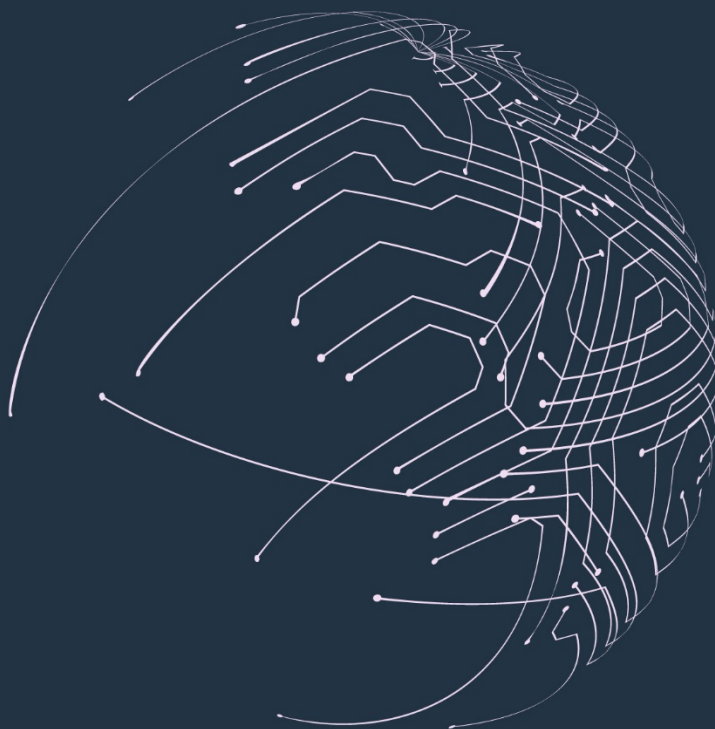


NRC-CNRC

OPEN SCIENCE ACTION PLAN



Response to the Government of Canada Roadmap for Open Science
National Research Council of Canada · June 2021



National Research
Council Canada

Conseil national de
recherches Canada

Canada

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Open science action plan: response to the Government of Canada Roadmap for Open Science

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1 Introduction

The National Research Council of Canada (NRC) has a rich history of creative collaboration and engagement with the scientific and research community, both in Canada and internationally. As Canada's largest federal performer of research and technology development, the NRC plays a leadership role within the Canadian science, technology, and innovation ecosystem by advancing scientific excellence, supporting industry and business innovation, and collaborating with government, academia and international partners.

As a Government of Canada institution, the NRC aligns with the Open Government and Open Science commitments of the federal government and science-based departments and agencies, and seeks to maximize the open release of our publications and research outputs to the greatest extent possible. Open Science is underpinned by principles of transparency, fairness, and equity, aligning fully with the NRC's vision of "A better Canada and world through excellence in research and innovation." The international scientific community's response to the global pandemic has clearly demonstrated the collective benefits of open and shared research methods, data and publications, and the NRC has played an important role in these efforts.

In 2020, the federal Office of the Chief Science Advisor issued the *Roadmap for Open Science*, which outlined core principles and 10 recommendations to guide Open Science activities in Canada. The recommendations call for a phased and incremental adoption of Open Science approaches, which apply to all federally funded scientific and research outputs. Since a number of recommendations require direct action by federal science-based departments and agencies, science departments were asked to develop a responsive action plan articulating specific commitments and goals that respond to the Roadmap's recommendations. This document outlines the NRC's commitments and actions.

The diversity of our research activities requires the NRC to take a range of approaches to open science. Some of our research and business activities necessitate the secure and confidential protection of data, including the confidential information of partners and clients, while in other research domains, the NRC is a leader in open research practices. Building on a solid base, this plan establishes a series of commitments aimed at enhancing and growing our open science practices, where feasible and aligned with the NRC's research and business practices. From these foundational activities, the NRC will continue to augment its open science practices, while also contributing to the shared commitments of the federal science community as a whole.

2 Context

2.1 About the NRC

As Canada's largest federal research and development organization, the NRC works with partners to deliver a national platform for innovation, by conducting research, supporting small and medium-sized enterprises, and enabling cross-sector partnerships and collaboration in Canada and abroad. Located in research facilities across the country, the NRC's scientists, engineers, technicians, and other specialists pursue leading-edge R&D opportunities in a wide range of research fields, including:

- aerospace engineering and manufacturing
- astronomy
- high-throughput DNA sequencing
- quantum photonics
- biotechnology
- nanotechnology, and more.

The NRC places a strong emphasis on research collaboration, and works closely with universities, other governments and research organizations, often in shared collaborative facilities, to explore research themes of shared mutual interest and work on game-changing scientific discoveries to advance specific objectives in a range of disciplines. The NRC also collaborates with international partners such as the United Kingdom, and has established offices in Germany and Japan. Internationally the NRC also plays a key role in a number of science and technology networks, and has been an adhering member to the International Science Council (ISC) since 1931. The NRC is active in 30 international scientific organizations, most of which fall under the ICSU umbrella, and engages in a range of global Open Science commitments through participation in these scientific unions.

2.2 The NRC's scientific publications

The NRC produces a range of publicly available scientific and research information. Among these are the publications of Codes Canada, many of which are now available directly through the NRC Publications Archive in free electronic format, as well as departmental publications used to plan and report on our research and business activities. The majority of the NRC's scientific publications are peer-reviewed and disseminated through commercial scientific publishers. For these types of publications, the NRC uses commercially available bibliographic databases to track output metrics and glean insights into the value and use of NRC-authored peer-reviewed publications, and these bibliometric indicators are incorporated into the NRC's performance measurement framework.

NRC researchers publish (as author or co-author) approximately one thousand peer-reviewed publications per year.¹ Between 2016 and 2020, the rate of publication was relatively stable with an average of 1,078 publications over the five year period (Figure 1).

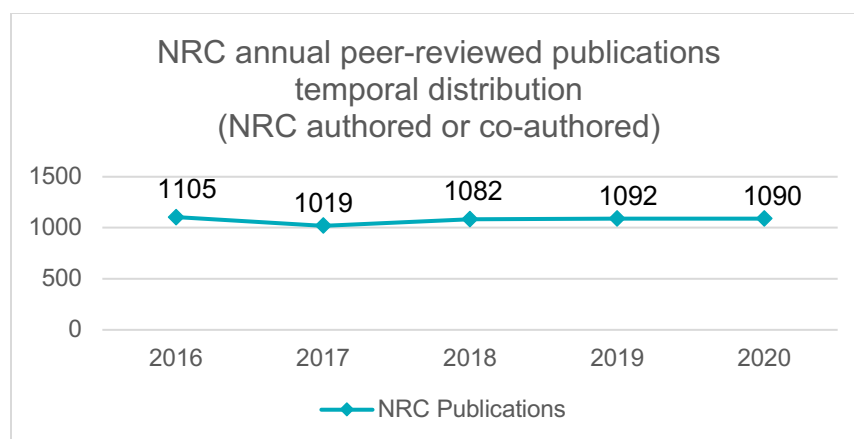


Figure 1: NRC annual peer-reviewed publications: Temporal distribution 2016-2020

In terms of publication type, the majority of NRC publications are peer-reviewed journal articles published in commercial journal publications, followed by some conference proceedings and books/book chapters (Figure 2).

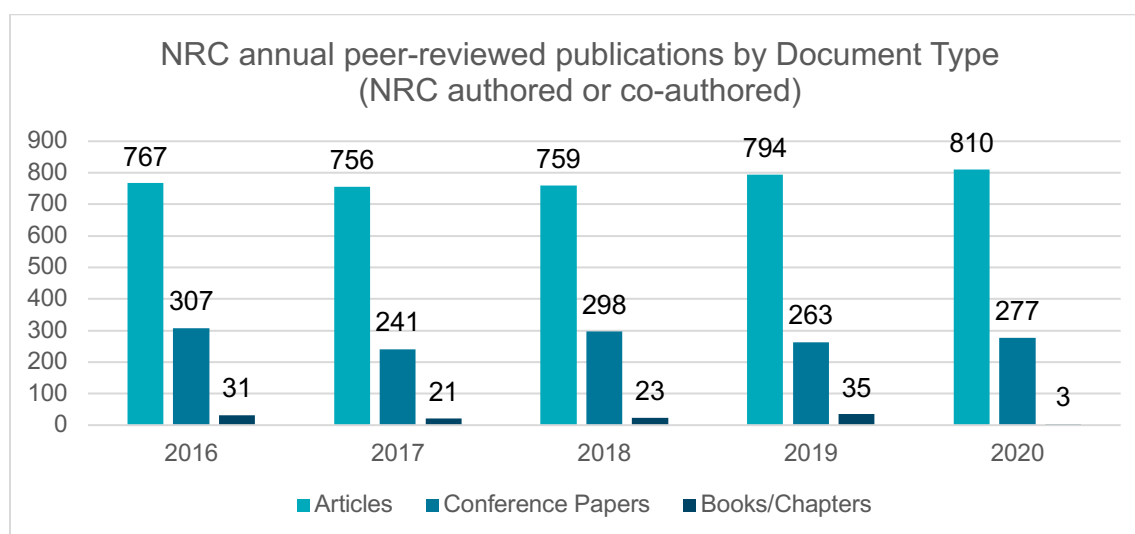


Figure 2: NRC annual peer-reviewed publications: Document types, 2016-2020

¹ All publication data used in this report was extracted from the Scopus database as of April 2021. Scopus is a large multidisciplinary abstract and citation database of peer-reviewed literature. Note that data for 2020 was not fully indexed at the time of data collection and the volume of publications is expected to increase for 2020.

The majority of NRC-authored publications are co-published with external collaborators (Figure 3).

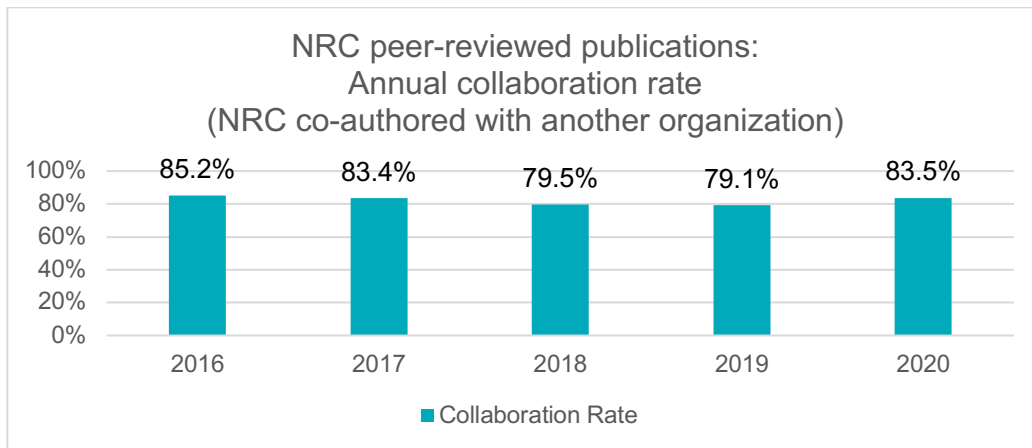


Figure 3: NRC peer-reviewed publications: Annual collaboration rate, 2016-2020

NRC researchers co-publish with Canadian and international organizations (Figure 4²). The top collaborators are the University of Ottawa (470 co-publications) and the University of Alberta (455 co-publications). The Centre national de la recherche scientifique (France) ranks third with 393 co-publications. Of the top collaborators, NRC co-publishes primarily with academic institutions followed by government organizations.

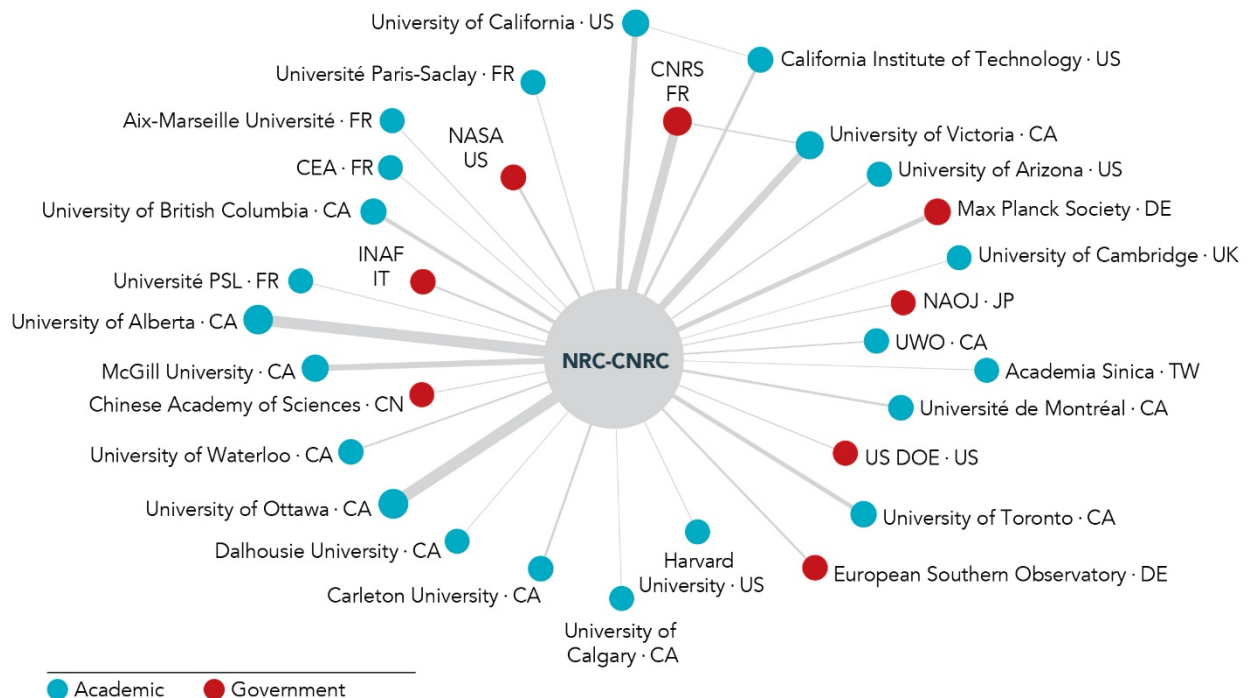


Figure 4: NRC Collaboration Network (≥100 co-publications), 2016-2020

² This network graph shows organizations with at least 100 co-publications with NRC. The thickness of the lines between the nodes represent the number of co-publications (thicker line equates to more co-publications) and the size of the node represents an organization's volume of publications.

Country Abbreviations: CA = Canada; CN = China; DE = Germany; FR = France; IT = Italy; JP = Japan; TW = Taiwan; UK = United Kingdom; US = United States

Organization Abbreviations: CEA = Commissariat à l'énergie atomique et aux énergies alternatives; CNRS = Centre national de la recherche scientifique; INAF = Istituto Nazionale di Astrofisica; NAOJ = National Astronomical Observatory of Japan; NASA = National Aeronautics and Space Administration; Université PSL = Université Paris Sciences & Lettres; US DOE = United States Department of Energy; UWO = Western University

NRC publications consistently achieve a solid scientific impact, demonstrated through a Field Weighted Citation Impact (FWCI) measure. The NRC's FWCI³ is consistently above the global mean of 1.00, indicating that the NRC's publication impact is higher than average (Figure 5). Although the FWCI constantly fluctuates, the average FWCI for the 2016-2020 period is 1.39 indicating that, on average, NRC publications are cited 39% more than the world average when compared to similar publications.

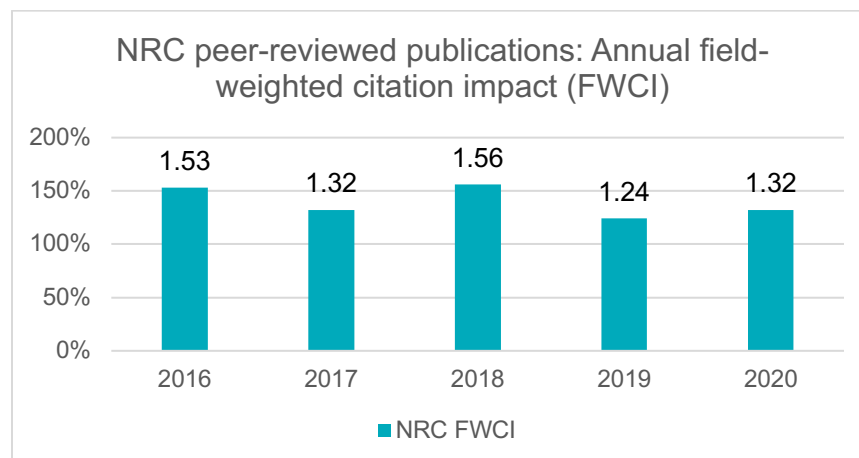


Figure 5: NRC peer-reviewed publications: Annual Field-weighted Citation Impact (FWCI), 2016-2020

2.3 Current state - Open Science at the NRC

Open Science involves commonly accepted principles and practices that apply across all research disciplines, as well as common accepted practices that have evolved within individual scientific domains. For the purposes of this action plan, the NRC has adopted the same general definition articulated in the *Roadmap for Open Science*. The roadmap defines Open Science as:

(t)he practice of making scientific inputs, outputs and processes freely available to all with minimal restrictions. Scientific research outputs include (i) peer-reviewed science articles and publications, (ii) scientific and research data and (iii) public contribution to and dialogue about science. Open Science is enabled by people, technology and infrastructure. It is practiced in full respect of privacy, security, ethical considerations and appropriate intellectual property protection⁴.

Open access publishing is one of the core tenets of Open Science, and the NRC has adopted various practices that enable open access publishing, including core investments in Green open access. The NRC Publications Archive (or “NPARC”) is an institutional repository of NRC-authored technical reports, peer-reviewed journal publications and conference proceedings, which serve as a valuable resource for

³ Field-Weighted Citation Impact (FWCI) is a normalized citation indicator that measures how well publications are cited compared to similar documents. The global average is always 1.00, thus a score higher than one means the publications have been cited more than average compared to similar publications of the same year, type and subject area. At the NRC, the FWCI is calculated based on articles, reviews and conference papers and is based on metrics from Scopus/SciVal.

⁴ Office of the Chief Science Advisor of Canada. (2020). *Roadmap for Open Science*. Retrieved from the Government of Canada website: [https://www.ic.gc.ca/eic/site/063.nsf/vwapj/Roadmap-for-Open-Science.pdf/\\$file/Roadmap-for-Open-Science.pdf](https://www.ic.gc.ca/eic/site/063.nsf/vwapj/Roadmap-for-Open-Science.pdf/$file/Roadmap-for-Open-Science.pdf)

researchers, collaborators and the public. Established in 2014, the repository contains over sixty thousand citations and approximately twenty thousand full text resources. NPARC provides a rich metadata schema, including persistent identifiers such as ORCID identifiers and Digital Object Identifiers (DOIs), which enable discoverability and linking across commercial and organizational research discovery platforms. Although publications deposited in NPARC are usually subject to an embargo period before they are eligible for open release, this established repository provides the NRC with a solid base from which to enhance and evolve open access publishing practices.

In addition to the use of NPARC, NRC researchers also publish in open access journals. There are currently no organizational requirements that mandate open access journal selection, although core principles that guide a researcher's journal choice are articulated in the *NRC Research and Scientific Integrity Policy*.

Looking at all forms of open access, the number of peer-reviewed open access publications has been relatively constant over the past 5 years. An average of 45% of NRC-authored total peer-reviewed published output has been made available through some form of open access (Figure 6).

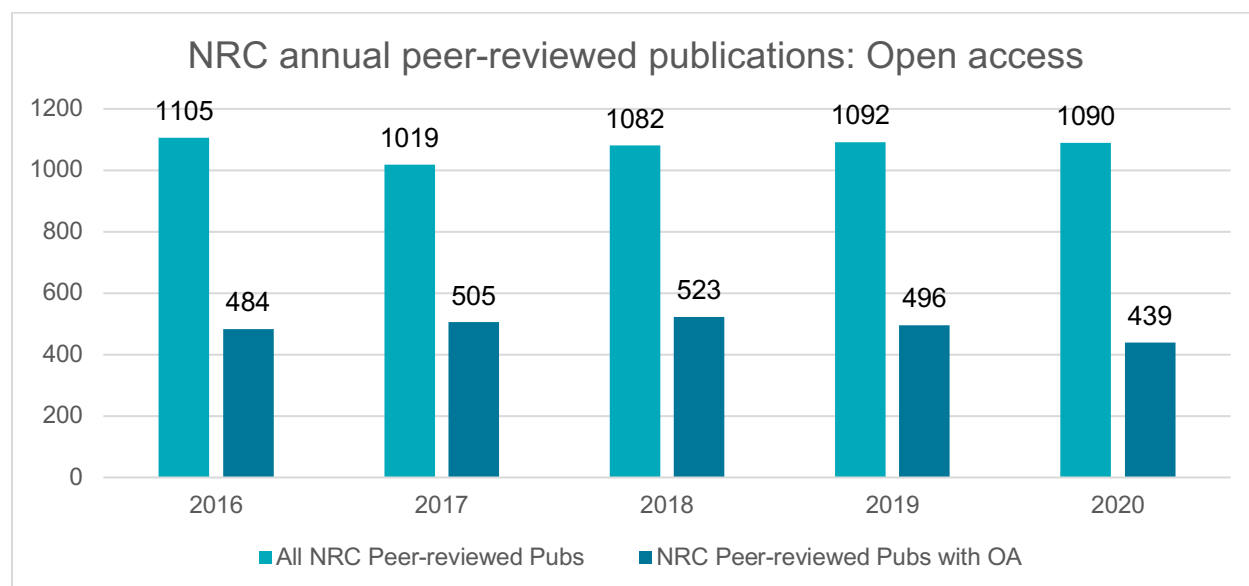


Figure 6: NRC annual peer-reviewed publications: Open access, 2016-2020

Open access publications of NRC-authored peer-reviewed content include those that are publisher-enabled open access (“Gold”, “Gold Hybrid” or “Bronze” open access) and “Green” open access (enabled via an institutional repository) (Figure 7).⁵ The use of the NRC’s institutional repository, NPARC, represents the majority of Green open access, but collaborator institutional repositories (such as partnering academic institutions) are also used for open deposit and dissemination. Figure 7 illustrates that, on average, 25% of the NRC’s 2016-2020 publications are available via publisher-enabled open

⁵ An Open Access document in Scopus can be tagged with more than one Open Access status as an article can be available in different Open Access versions (such as Gold and Green). However, there is not duplicate counting for publisher-enabled OA documents (Gold, Hybrid-Gold, and Bronze categories). This mean the “Green” category may include a number of the publisher-enabled Open-Access content and adding the two categories will not equal the total number of Open Access publications at NRC.

access (“Gold”, “Gold Hybrid” or “Bronze” open access) leaving, on average, 20% of NRC open access publications available solely through “Green” open access via repositories such as NPARC, with or without embargo period.

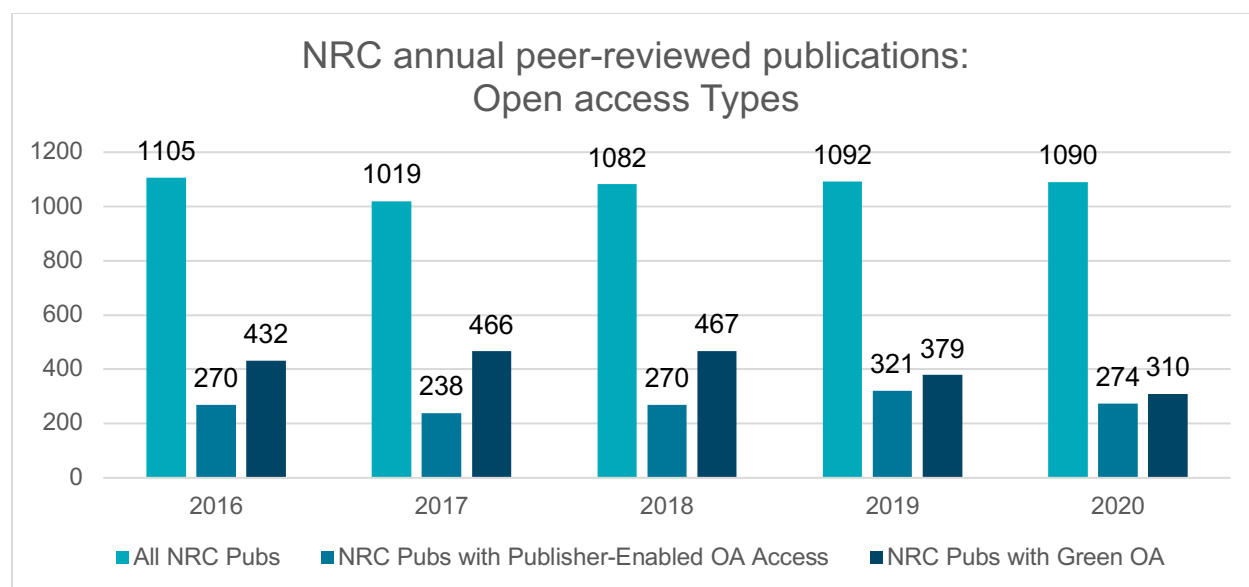


Figure 7: NRC annual peer-reviewed publications: By type of open access, 2016-2020

Five year trending indicates that open access publishing rates are slightly higher for publications in which NRC authors co-publish with external collaborators (Figure 8). For example, in 2020, while 84% of all 2020 NRC publications were co-authored with another institution, 91% of the publisher-enabled open access publications and 95% of the Green open access NRC publications were co-authored with another institution. Overall, in 2020, 406 of the 439 NRC open access publications were co-published with external collaborators (92.5%).

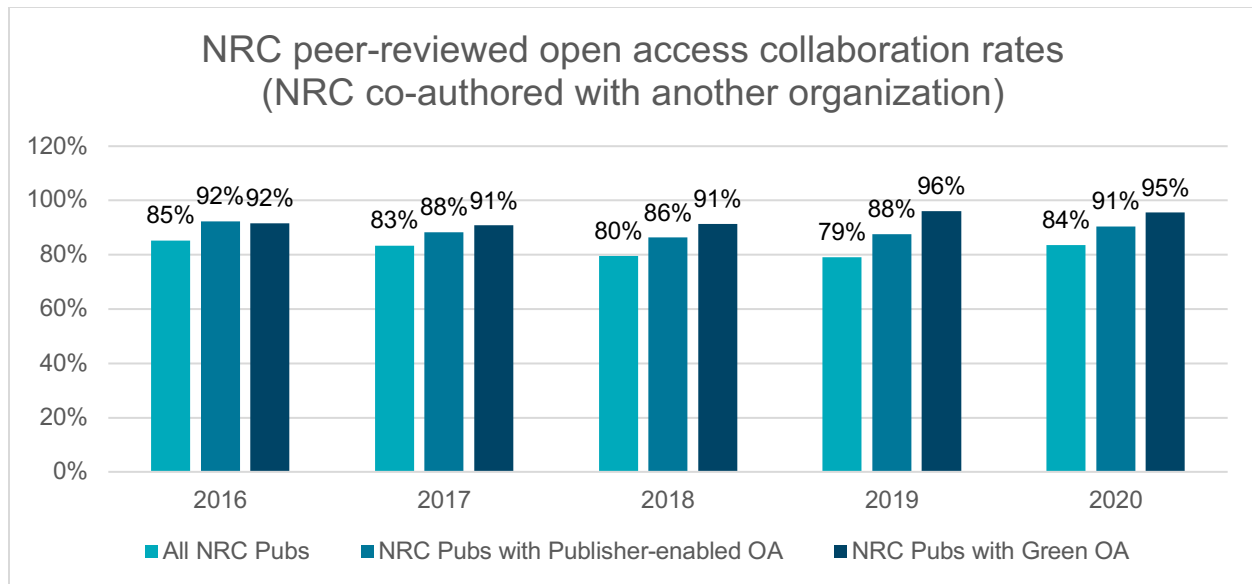


Figure 8: NRC Collaboration rates: Total NRC publications vs open access, 2016-2020

Looking at the five year period, the top NRC collaborator for open access peer-reviewed publications is the Centre national de la recherche scientifique (France) with 360 open access co-publications. The University of Victoria (Canada) ranks second, and the University of California (USA) ranks 3rd with 277 publications. Overall, just over half of the organizations co-publishing open access publications with the NRC are international organizations. One NRC Research Center, the Herzberg Astronomy and Astrophysics Research Centre (HAA), Canada's foremost authority on astronomy and astrophysics, has published approximately one-third of the NRC open access peer-reviewed publications between 2016 and 2020.

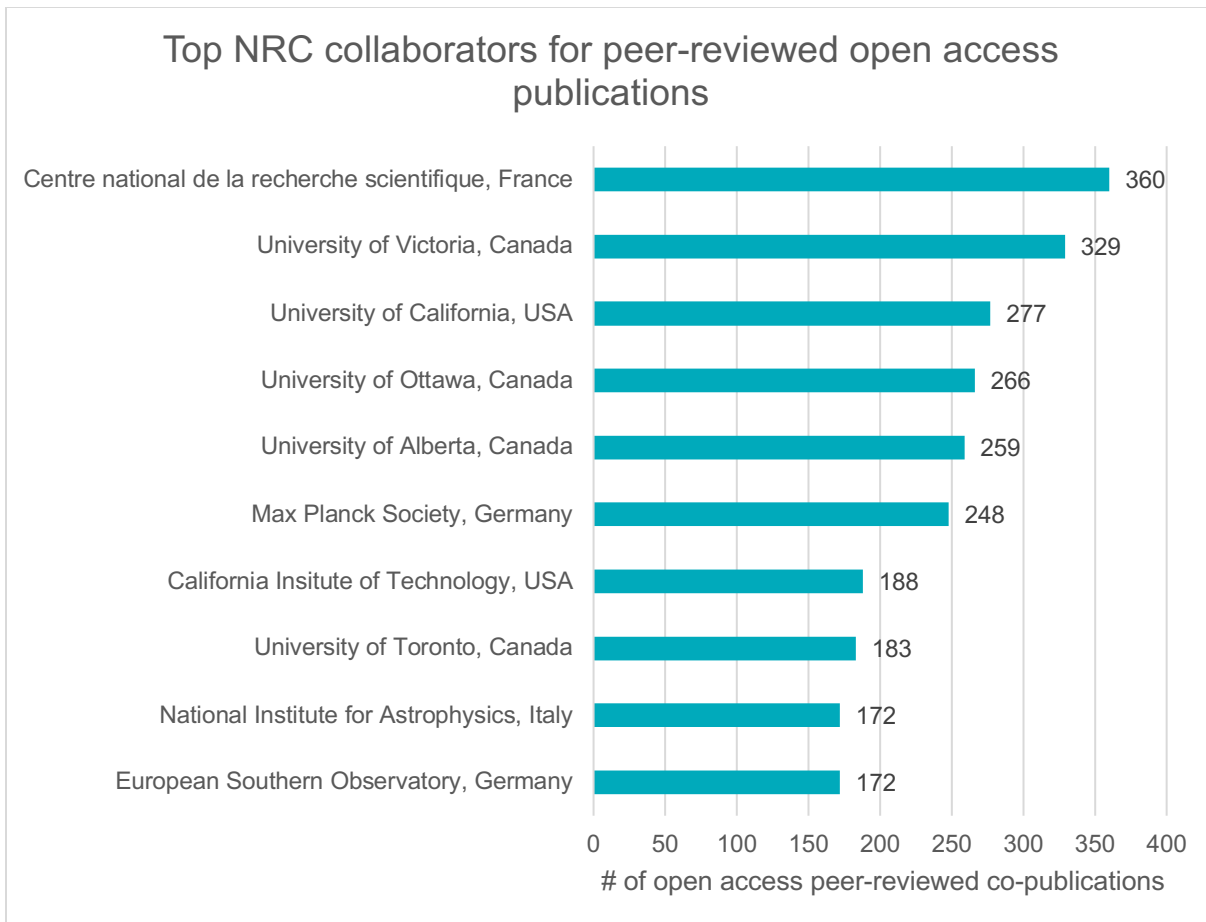


Figure 9: Top NRC collaborators for peer-reviewed open access publications, 2016-2020

Open access publications at the NRC are generally cited more than average compared to similar publications of the same year, type and subject area. In fact, FWCI tends to be higher for NRC open access publications than for all NRC publications, indicating that open access publications have a larger scientific impact than non-OA publications (Figure 10).

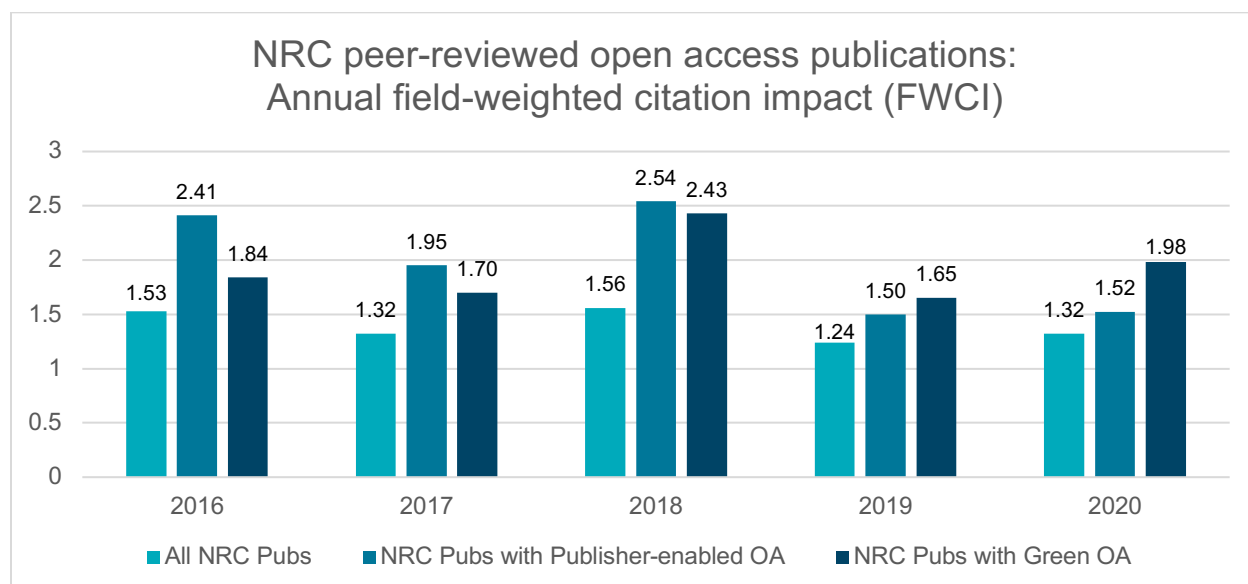


Figure 10: NRC open access publications: Field-weighted citation impact (FWCI), 2016-2020

The NRC also contributes to the effective discovery of open access publications through its role as operational lead for the Federal Science Libraries Network (FSLN). The FSLN provides access to a shared library catalogue and discovery platform, aggregating the print and digital publication holdings of seven federal science libraries including Agriculture and Agri-Food Canada, Environment and Climate Change Canada, Fisheries and Oceans, Health Canada, Natural Resources Canada, the NRC, and the Public Health Agency of Canada. The NRC also provides digital subscription services to the FSLN, and is currently exploring transformative agreement options with one of the major publishers through this co-funded model.

In terms of open data, a comprehensive snapshot of the NRC's current Open Science activities is more challenging, as commercially available bibliographic sources do not offer the same holistic picture of data publication and open release, and data practices are embedded within the diverse research activities underway across the organization. A current state assessment demonstrates that some research centres have established open data practices that align with their own internal business and research activities, collaborator requirements, and general trends within their areas of scientific activity and research. A key example is the Herzberg Astronomy and Astrophysics (HAA) Research Centre. Responsible for Canada's largest and most powerful observatories, HAA provides extensive data management and analysis tools through the Canadian Astronomy Data Centre.



The Canadian Astronomy Data Centre (CADC) is one of the largest and most powerful astronomy data management centres in the world, housing some of the world's most important astronomical data collections, including those from the Canada-France-Hawaii Telescope (CFHT), the twin Gemini telescopes and the James Clerk Maxwell Telescope.

Delivering over a petabyte (1 million gigabytes) of data to nearly 6,000 astronomers each year, CADC data has helped safely guide the first close spacecraft encounter with Pluto and enabled the discovery of supermassive black holes that reveal secrets to the origin of the Universe. CADC's data collection, along with its world-leading cloud infrastructure for astronomy, provides a unique resource for data-intensive astrophysical research.

As part of the international astronomy community, HAA is a leader in the curation, sharing and management of large data sets.

The Metrology Research Centre delivers high-precision measurement science, maintains Canada's official time, and maintains a comprehensive suite of mass spectrometers for speciation and quantification. Given the discipline's emphasis on international standardization, Metrology's staff, including Canada's Chief Metrologist, are highly engaged in international Open Science activities in areas of measurement science.

The NRC is also in the process of providing enterprise services that support the release of open data, including exploratory activities with Canada's New Digital Research Infrastructure Organization (NDRIO), and the publication of data sets through the NRC Digital Repository.

2.4 Internal consultations on Open Science

To move towards a common definition of Open Science and share thoughts on the challenges and opportunities that Open Science presents for the NRC, various consultation activities have taken place to date. These include online engagement through a collaborative platform in 2018, discussions at governance and researcher committees, and a series of consultative discussions led by the NRC Departmental Science Advisor in 2020. Key findings from these consultations include:

- Enterprise governance over Open Science should be strengthened. Despite Open Science engagement in various research centres and enabling corporate groups, the NRC does not currently have an enterprise articulation of goals, targets and expectations.
- Open Science awareness varies between research centres, and at the individual researcher level. Open access publishing practices vary considerably depending on the field of research and other factors, including career stage.
- Researchers recognize the importance of Open Science to accelerate scientific discovery, and are committed to sharing within their scientific communities, except where specific restrictions (such as confidentiality) apply. The sharing of research data with peers and collaborators is often a higher priority for individual researchers than open access publishing.

- It is a priority for researchers, as well as for the NRC as a whole, to establish an appropriate balance between enabling open/collaborative research, and the need to protect sensitive, confidential and proprietary data. New guidance, tools and technologies are required to assist in this critical exercise.
- The NRC's Open Science frameworks should take into consideration the diversity of NRC research outputs, while providing clear guidance on expectations and best practices.
- The NRC *Research and Scientific Integrity Policy* provides researchers with flexibility in journal selection, when publishing. Many factors can influence choice of journal, including journal reputation and impact/reach, shared decision-making with external collaborators, and open access publishing. While retaining decision-making authority, research groups would benefit from additional tools and guidance to assist in these processes.
- NRC researchers are largely aware of the NRC's institutional repository (NPARC), but not all are fully aware of the importance of this repository for enabling open access, or their own responsibilities in meeting deposit requirements.
- Meeting embargo-free open access publishing targets would require new funding sources.
- Given the diversity of the NRC's research activities, security considerations, and concurrent information technology (IT) renewal activities, enterprise open data initiatives will require detailed consideration in the coming years.

Consultation findings informed the action items articulated in the next section. In moving forward with Open Science, the NRC is taking an iterative approach, building on existing strengths and establishing flexible enterprise frameworks that can be adapted as needed to reflect the diversity of the NRC's research activities.

3 Action plan

Proposed action items that respond to the recommendations of the *Roadmap for Open Science* and which will continue to enhance and build on existing Open Science practices are organized in four action areas:



3.1 Action area #1: Building an “open” culture

Action	Activities	Timelines
Establish governance	Confirm Chief Scientific Data Officer and other designated roles and responsibilities for Open Science at the NRC.	September 2021
	Confirm committee governance to ensure an ongoing dialogue and consultations on Open Science between research centres, senior management, and enabling policy and service leads.	September 2021

Action	Activities	Timelines
	Establish a data governance committee which, as a component of overall data strategy implementation, incorporates open/FAIR ⁶ principles and actions.	September 2021
	Establish Open Science leads within research centres and a community of practice (CoP) model for horizontal coordination and sharing of enabling services, tools, & best practices.	November 2021
Confirm target state	Leveraging the CoP, complete a detailed as-is assessment, including an inventory of research centre-specific processes and practices, as well as enterprise tools and services.	January 2022
	Through consultation, depict a target state for NRC Open Science that aligns with Roadmap recommendations and reflects the NRC's own business context.	May 2022
	Update existing NRC policies, where applicable, to ensure alignment with Open Science governance, roles and responsibilities.	July 2022
	Review the OCSA Guidance on Open by Default and finalize NRC-specific guidelines, to ensure consistent policy guidance on the types of information and data that are eligible for open release. (Training and awareness to be addressed under action areas 2 and 3).	July 2022

⁶ Findable, Accessible, Interoperable, and Reusable

3.2 Action area #2: Enabling open access to our published research

Action	Activities	Timelines
Increase NRC awareness and adoption of open access publishing practices	Develop an Open Access Publishing toolkit for researchers and promote across the NRC research community to confirm the types of information eligible for open access, increase NPARC deposit rates, and maximize Green, Gold and hybrid open access publishing.	Toolkit: March 2022 — promotion ongoing
	Explore options for obtaining discounted open publishing fees (Article Processing Charges) for Gold open access, through new library/publisher agreements within the NRC and on behalf of the Federal Science Libraries Network (FSLN).	Phased, starting in April 2021
	Through consultation with research centres, develop an inventory of NRC science publications other than peer-reviewed journal articles, book chapters and conference proceedings, to ensure these are deposited to NPARC and that procedures and repository practices are updated as needed to accommodate all eligible research publications.	November 2022
Develop and enhance solutions to enable the discovery of federal science outputs	Develop an automated submission process for NRC researchers to easily deposit copies of peer-reviewed research publications in NPARC.	March 2022
	Continue to work with the Office of the Chief Science Advisor, Shared Services Canada, the Federal Science Libraries Network, and other science departments to develop and evolve efficient, integrated and interoperable open repositories for federal science publications.	Underway and ongoing
	Continue to participate in horizontal initiatives with the broader Canadian research ecosystem, to co-develop integrated discovery platforms and open repositories.	Underway and ongoing

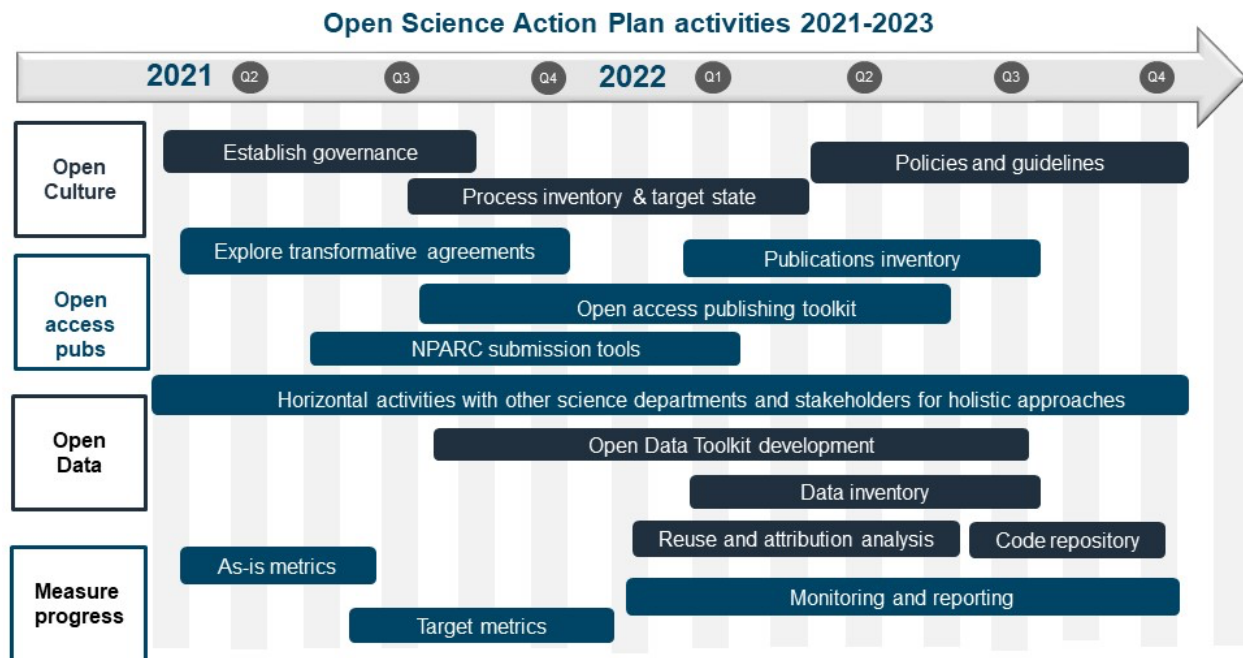
3.3 Action area #3: Increasing the openness of our research data

Action	Activities	Timelines
Increase NRC awareness and adoption of open data release practices, including FAIR principles	<p>Collaboratively develop and launch an Open Data toolkit for researchers and promote across the NRC research community. Elements of the toolkit will address:</p> <ul style="list-style-type: none"> • Types of research data that can be disclosed (per Guidelines on Open by Default) • Services available for NRC researchers • Repository options for open data deposit • Use of persistent identifiers (ORCID, DataCite DOIs) • Metadata and notation standards • Data Management Plan (DMP) best practices and templates • Guidance on the simultaneous publication of underlying/related data sets with peer-reviewed publications 	<p>Toolkit: September 2022 — promotion ongoing</p>
	As part of an integrated data strategy, establish a descriptive inventory of eligible NRC data that meet open data criteria. Leverage the inventory to plan and execute incremental growth of NRC open data practices.	November 2022
Confirm standardized approaches for attribution and reuse of NRC data that has been made open to the public	Examine existing models and best practices for re-use and attribution of open data; establish appropriate NRC model(s) and promote through the Open Data toolkit.	September 2022
	Establish an institutional platform and supporting processes for the open sharing of eligible source code (e.g. GitHub).	March 2023

3.4 Action area #4: Measuring our progress

	Action	Timelines
Confirm current state and incremental goals	Baseline “as is” metrics for open access publishing and release of open data.	September 2021
	Establish targets and incremental milestones for OA publishing and open release of data sets.	December 2021
Report on progress	Develop an indicators dashboard and report quarterly on progress through governance.	Quarterly, beginning in December 2021

4 Summary of actions and timelines



5 Conclusion

Open Science is a core component of the NRC's research and business context. Along with other science-based departments and agencies, and in step with the broader research community, the NRC will continue to build on current "open" practices by executing on action items outlined in this plan. These actions are intended to foster an organizational culture that recognizes and applies Open Science practices where appropriate; incrementally maximize the open release and sharing of the NRC's scientific publications and data; and ensure an appropriate balance between openness and the need to protect sensitive research. Following the principles established by the *Roadmap for Open Science*, and through shared and collaborative approaches, the NRC will continue to contribute to the Government of Canada's Open Science goals, creating new opportunities for innovation, partnership, and scientific discovery.

