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The state of green open access in Canadian universities
L'état de libre accès vert dans les universités canadiennes

Poppy Riddle, Marc-André Simard, Pallavi Gone, Vinson Li et Philippe Mongeon

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Résumé de l'article

Cet article étudie l'utilisation des dépôts institutionnels pour l'autoarchivage des publications évaluées par les pairs parmi les universités du U15 (une association de quinze universités canadiennes axées sur la recherche). Il combine l'utilisation de ces dépôts avec les types de stratégies de libre accès des universités ainsi que les politiques d'embargo des éditeurs scientifiques. Nos résultats démontrent que les articles attribués aux chercheuses et aux chercheurs des U15 ont des taux de disponibilité en libre accès doré et vert variant de 45,1 à 56,6%, mais seulement 0,5 à 10,7% (moyenne de 4,2%) d'entre eux peuvent être trouvés dans les dépôts institutionnels de leur université. Notre enquête révèle également une absence de politiques de libre accès dans la plupart des institutions, des politiques de libre accès de revues avec des embargos de plus de 12 mois et des informations incomplètes.

The state of green open access in Canadian universities

L'état de libre accès vert dans les universités canadiennes

Poppy Riddle
Dalhousie University

Marc-André Simard
Université de Montréal

Pallavi Gone
Dalhousie University

Vinson Li
Dalhousie University

Philippe Mongeon
Dalhousie University & Université du Québec à Montréal

Abstract: This study investigates the use of institutional repositories for self-archiving peer-reviewed work in the U15 (an association of fifteen Canadian research-intensive universities). It relates usage with university open access (OA) policy types and publisher policy embargoes. We show that of all articles found in OpenAlex attributed to U15 researchers, 45.1 to 56.6% are available as Gold or Green OA, yet only 0.5 to 10.7% (mean 4.2%) of these can be found on their respective U15 IRs. Our investigation shows a lack of OA policies from most institutions, journal policies with embargoes exceeding 12 months, and incomplete policy information.

Keywords: Open access, OpenAlex, institutional repository, bibliometrics, open access policy, Canadian universities

Résumé : Cet article étudie l'utilisation des dépôts institutionnels pour l'autoarchivage des publications évaluées par les pairs parmi les universités du U15 (une association de quinze universités canadiennes axées sur la recherche). Il combine l'utilisation de ces dépôts avec les types de stratégies de libre accès des universités ainsi que les politiques d'embargo des éditeurs scientifiques. Nos résultats démontrent que les articles attribués aux chercheuses et aux chercheurs des U15 ont des taux de disponibilité en libre accès doré et vert variant de 45,1 à 56,6%, mais seulement 0,5 à 10,7% (moyenne de 4,2%) d'entre eux peuvent être trouvés

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Mots clés : Libre accès, OpenAlex, dépôt institutionnel, bibliométrie, politique de libre accès, universités canadiennes

Introduction

The Open Access (OA) movement has evolved over the last 20 years and now permeates all aspects of scholarly production. In Canada, there is a long history of involvement in OA, starting with the Budapest Open Access Initiative (BOAI) (Morrison and Waller 2008), originally signed by three Canadian researchers: Leslie Chan, Jean-Claude Guédon, and Stevan Harnad. The Canadian Association of Research Libraries (CARL) was also an early signatory of the initiative. There followed an open access mandate by the Canadian Institutes of Health Research (CIHR) "requiring open access to CIHR-funded research within six months" (Morrison and Waller 2008), which eventually evolved into the Tri-Agency Open Access Policy on Publications (Government of Canada 2016). Correspondingly, the CARL Institutional Repositories Program supports the development and advancement of institutional repositories (IRs) in Canada through promotion, recruitment of new content, and uniformity of services provided by IRs across institutions ("Institutional Repositories Position Statement" 2003).

IRs have developed globally, with cultural responses to publication and dissemination needs reflected in the significant different usage across countries and regions with usage differing substantially across countries and regions, and growth rates plateauing in North America, Germany, and the UK (Moskovkin et al. 2021) due to saturation (Pinfield et al. 2014). Despite being an early signatory and the home of prominent OA champions, Canada is not at the forefront of OA (Moskovkin et al. 2021; Simard et al. 2022); Canada appears in the top 10 countries with the most OA repositories but lacks OA participation from researchers compared with other high-income countries (Moskovkin et al. 2021). Differences in the uptake of OA by researchers have also been highlighted across provinces (Larivière and Macaluso 2011; Paquet, van Bellen, and Larivière 2022). Despite having well-established, multidisciplinary, and Open Archives Initiative OAI-compliant IRs, Canadian universities belonging to the U15, an association of fifteen Canadian research-intensive universities, exhibit low deposit levels (Paquet, van Bellen, and Larivière 2022) and more research is needed to analyze the effectiveness of initiatives and policies prescribing their use.

Despite increased recognition of the importance of OA (Creaser et al. 2010) and, more broadly, Open science (Boulton et al. 2020; "UNESCO Recommendation on Open Science" 2021), little attention has been given to the use of the IR by researchers within a Canadian university specifically for self-archiving peer-reviewed journal publications, and how IR use may be affected by university policies, journal self-archiving policies, or disciplinary cultures. While past research has looked at self-archiving rates in Canada (Paquet, van Bellen, and Larivière 2022) and globally (Simard et al. 2022), this work is, to our knowledge, the first to focus on the use of IRs specifically and consider institutional and journal OA policies. Another unique feature of our work is its reliance

solely on open data sources. Previous work relied on proprietary databases such as Dimensions, Scopus, and the Web of Science. We hope to understand the factors that may facilitate or inhibit OA practices by researchers and organizations, how disciplinary differences may contribute to IR usage, and how policies from the university and publishers may or may not be contributing to an increased usage of the IRs.

Research objectives

This study aims to provide an overview of the uptake of OA in Canadian universities that are members of the U15, focusing on the usage of their institutional repositories and possible correlations between characteristics of university OA policies and publisher policies. Specifically, we aim to provide answers to the following research questions:

1. What OA policies are in place in the U15, and is there a relationship between policy types and IR usage?
2. What are the characteristics of the OA policies of journals in which the U15 publishes in terms of self-archiving in IRs, the manuscript version allowed for deposit, and embargo periods?
3. What percentage of the research output from the U15 is available as OA and in IRs?
4. Are there disciplinary differences in OA publishing and IR usage?

Literature review

The OA movement is a reaction to several conditions affecting the research community and the public. Researchers advocating for OA in Budapest in 2001 (Solomon and Björk 2016), on the heels of PubMed's birth from the National Institutes of Health (NIH) (Solomon and Björk 2016), were responding to various issues affecting information dissemination and access across the globe. Conditions both directly related to publishing, such as the pricing crisis for libraries (Larivière, Haustein, and Mongeon 2015), and indirectly related, such as the growth and improving ubiquity of the internet, are possibly the two most significant contributors to the OA movement's acceptance (Suber 2015; Vincent-Lamarre et al. 2016). Publishing-related issues, such as Big Deal leveraging (Larivière, Haustein, and Mongeon 2015), issues of monopolization--not only of research output but also the Ingelfinger law (Larivière, Haustein, and Mongeon 2015; Suber 2012)--in addition to issues of sustainability and unscalability of the subscription model (Suber 2012), have added to the realization of OA's necessity from the academic community, government, and funding organizations.

Types of OA

Many types of OA (e.g., green, gold, hybrid, bronze, and diamond) have been discussed in the literature. These labels are determined by factors such as location of the freely accessible version of the paper, type of journal, whether article processing charges must be paid, and the presence of a license under which the paper is published. Our study focuses on Green OA and Gold OA, with Green OA operationalized as a version (preprint, post-print, or published) of a journal article deposited in some

publicly accessible archive (Piwowar et al. 2018). Gold OA is operationalized for this study as the published version of a journal article freely available on the publisher's website. In principle, an article could be considered Green OA if it was deposited on a personal website (Björk et al. 2014). But, since personal websites are often not harvested by platforms like Google Scholar and Unpaywall, these papers were not included in our analysis. Similarly, articles shared on Academic Social Networks (ASNs), such as ResearchGate.com and Academia.edu, are typically not considered Green OA (Piwowar et al. 2018) since access requires registration.

IRs and their role in OA

There are two main types of repositories: disciplinary repositories (e.g., ArXiv) and institutional repositories. This study focuses on the Canadian universities' IRs, which are local or cloud-based digital storage facilities usually managed by the university library to preserve and make available research output, theses, teaching material, datasets, etc., produced within the organization. The definition from the Canadian Association of Research Libraries ("Institutional Repositories Position Statement" 2003) provides additional emphasis on "reassert[ing] control over Canadian scholarship", presumably in response to the privatization of publicly funded assets that preceded the OA movement. IRs are now expected to be searchable using the OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting) standard to enable data mining (Björk et al. 2014), allowing the creation of services like Unpaywall (https://unpaywall.org/) and aggregators like BASE and CORE. Depending on the publisher's self-archiving policies, IRs may contain different versions (preprint, post-print or published) of peer-reviewed publications (Björk et al. 2014). Preprints are works published before peer review, giving authors the earliest possible timestamp and are usually immediately available without an embargo from the journal. Post-prints are the accepted manuscript or the published article that has been peer-reviewed and is the authors' final version. Published articles are the exact digital version of published articles, as found in Gold OA contracts. An IR may have multiple versions of an author's article, which can change over time.

The role of libraries

Libraries and their librarians have held a key and assumed position in OA, and we would be remiss to skip their contributions to OA and IR implementation. They were already situated at the center of scholarly publishing, dissemination, and addressing issues of "technical, educational, enforcement and interpretation of copyright, verification of deposited copyright compliance, determination of metadata, uploading of copies to the IR" (Björk et al. 2014) as well as implementation as proposing, drafting, and implementing OA institutional policies (Fruin and Sutton 2016). This may place librarians in a role of education and clarification on funder policies which may be the only authoritative voice in the absence of university OA policy. Ducas, Michaud-Oystryk, and Marie Speare (2020) studied the roles of academic librarians in Canada. 83% of their participants responded that Scholarly Communication, including OA, copyright, and consultation on funder mandates was part of their job responsibilities. However, efforts can be severely challenged by the disconnect between librarians managing information sources and deals between publishers and other departments (Antelman 2017),

particularly for the delayed effect of publisher policies. While open educational resources (OER), OA education, and library OA statements (Tummon and Desmeules, 2022) are well established in the U15, it is beyond the scope of this study to analyze their effect on the use of IRs for self-archiving peer-reviewed works.

OA policies

One way to increase adoption of Green OA is the implementation of OA policies. These policies are generally adopted by funders, research organizations such as universities or research institutions, or sub-units of an organization such as departments, faculties, or schools. Typically, OA policies are related to universities and research institutions (Mering, 2020). They aim to encourage or require researchers to share their research results and/or data through a scientific journal or an online platform such as an OA repository (Suber 2012). These policies are generally based on the idea that publicly funded research should be made available to everyone and that this broader availability would allow researchers who do not have access to paywalled scholarly literature to participate in science and build on past research results (Larivière and Sugimoto 2018; UNESCO 2021). Harnad (2015) has documented the main qualities required for an OA policy to be effective, including the presence of an IR, the deposit of the final draft immediately upon acceptance, authors' rights retention, and compliance as a method for local research evaluation. Lasthiotakis et al. (2015) also similarly provided a framework for OA or open science policies, recognizing that there are variations due to disciplinary standards.

Institutional OA policies

Institutional OA policies play a very different role than funders' OA policies and are generally less restrictive. They may include clauses specifying the strength of deposition requirements, locus and timing of deposit, recognition of publisher embargoes, retention of author rights, and use of IR deposits for faculty evaluation (Suber 2012). These criteria may vary significantly from one institution to another. In universities, libraries may play a key role in developing OA policies or statements of commitment to OA (Fruin and Sutton 2016). The latter tend to be shorter non-prescriptive texts that encourage OA adoption instead of prescriptive policies detailing integration into existing services, collections, and systems (Scott, Harrington, and Dubnjakovic 2021) that require formal approval by the University Senate.

De Filippo and Mañana-Rodríguez (2020) have shown that institutional policies have a positive effect on the visibility of research, but generally require the creation and maintenance of the appropriate infrastructure. The institutional culture of a university may also have a certain effect on the type of OA policies possible in a university. Using compliance with an OA policy as local research evaluation criteria may also encourage researchers to increase their participation in OA (Vincent-Lamarre et al. 2016). Vincent-Lamarre et al. (2016) found a small—but significant—correlation between OA policy conditions and OA deposits, particularly with strong mandates that required immediate deposit, using deposit for performance evaluation, and required deposit despite an OA opt-out clause.

Finally, in lieu of an institutional policy, institutions may also be signatories or declare support for other OA statements. The Budapest Open Access Initiative (BOAI), the Bethesda Statement on Open Access Publishing, the Berlin Declaration (Suber 2012), and the International Federation of Library Associations and Institutions (IFLA) establish OA positions that institutions can adopt or recognize as a commitment to OA practices. Acknowledging the variety of ways an institution can establish an OA position, institutional policies can range from strong mandates to statements of commitment to encourage OA participation.

Funders OA policies

Funder policies are an effective way to increase use of OA repositories (Larivière and Sugimoto 2018). As an example of strong OA mandates, the NIH mandated the use of the PubMed Central repository for funded research (Archambault et al. 2014), leading to high OA publication rates in the Health Sciences field (Holter 2020). In Canada, funding agencies also have policies on OA to ensure that the funded research is freely available to the public. The Tri-Agency Open Access Policy on Publications (TOAPP) includes the following three agencies: the Canadian Institutes of Health Research (CIHR), the Natural Sciences and Engineering Research Council of Canada (NSERC), and the Social Sciences and Humanities Research Council of Canada (SSHRC) (Government of Canada 2016). The harmonized policy stipulates that grant recipients are required to ensure that their publications are openly accessible within a year of publication using institutional or disciplinary repositories (Government of Canada 2016). The Tri-Agencies have recently announced a review of the current OA policy that should be released by the end of 2025[1]. Written for a purpose similar to the *Tri-Agency Open Access Policy on Publications*, the *Politique de diffusion en libre accès des Fonds de recherche du Québec* (2019) emphasizes the importance of the dissemination of academic research results to the public, particularly when those projects were funded by the Fonds de recherche du Québec (FRQ). The policy stipulates that research funded by the FRQ must be made accessible to the public without cost through an institutional or disciplinary repository within a year of publication unless the journal/publisher provides OA. The FRQ applies only to researchers in Québec and therefore places significance on disseminating research in French (*Politique de diffusion en libre accès des Fonds de recherche du Québec* 2019). Recent changes in Québec may help improve compliance for FRQ-funded researchers and their institutions with the commitment of the FRQ to Plan S, due to start in March 2023 ("Plan S Principles and Implementation" n.d.). This will require authors to make their articles available immediately upon publication instead of the 12-month delay (Birsan 2021).

Journal OA policies

Journal self-archiving policies typically specify the versions of the paper that can be self-archived (preprint, post-print, and published) and where they can be deposited (e.g., personal websites, institutional, or subject repositories). However, journals are

[1] https://science.gc.ca/site/science/en/interagency-research-funding/policies-and-guidelines/open-access/presidents-canadas-federal-research-granting-agencies-announce-review-tri-agency-open-access-policy

less permissive for self-archiving in subject repositories (Laakso 2014). Furthermore, publishers cultivate, knowingly or not, the resignation of authors due to complex copyright and license agreements that may discourage them from depositing their work in IRs even when it is allowed (Draper and Turow 2019). Embargoes may also lead researchers to forget to complete the deposition once the embargo has expired (Larivière and Sugimoto 2018). A study of neuroscience journals by Khoo and Lay (2018) found that Elsevier is the only large commercial publisher without a standard policy and with many journal embargoes exceeding 12 months. Teixeira da Silva and Dobránszki (2019) evaluated policies from fourteen academic publishers finding that a little less than 50% of all publishers on the Sherpa (Securing a Hybrid Environment for Research Preservation and Access) Romeo database had self-archiving policies and that by 2018, 78% of the top 14 publishers had policies relating to the self-archiving of preprints. However, the lack of standardization and numerous exceptions and omissions, particularly with large publishers such as Elsevier, may contribute to the "stifled growth" of preprint availability despite the growth of IRs (Teixeira da Silva and Dobránszki 2019).

Self-archiving practices and compliance with OA policies

Many studies have examined IR usage and compliance with policies. Khoo and Lay (2018) studied neuroscientists' publishing behaviours, in which they found "no evidence that funder open access policies reduce the rate at which neuroscientists publish in Elsevier journals with non-compliant embargo periods of more than 12 months." Failing to self-archive is not unusual and is the case for most academics (Gargouri et al. 2010; Harnad 2010; Vincent-Lamarre et al. 2016). Creaser et al. (2010) also identified that IRs are underpopulated despite authors supporting OA in principle. They found that authors identified barriers to deposit regarding copyright and embargo periods. Disciplinary differences may account for low-deposit rates in IRs as the Physical Sciences and Mathematics prefer subject repositories, while the Social Sciences, Humanities, and Arts utilize IRs more than other disciplines (Creaser et al. 2010). The use of subject repositories by Physical Sciences predates those of IRs, so this disciplinary evidence is unsurprising, as self-deposition behaviour is considered a normal part of the workflow (Creaser et al. 2010). Pinfield et al. (2014) identified OA mandates as an essential driver for developing and using repositories.

Paquet van Bellen, and Larivière (2022) examined OA across Canada and found trends increasing for OA deposition across disciplines from 2015 to 2019 when measured by the funding organization. They examined funder policies across Canada, including private organizations, and found that while some provinces, such as Québec, publish in OA at a higher rate, much improvement could be made in OA participation. They found that the health discipline leads OA deposit and attribute this to the stronger CIHR and FRQ-S funding, as well as "entanglement" with NIH funding from the US, which has strict repercussions for lack of compliance (Paquet, van Bellen, and Larivière 2022). They also identified that Natural Sciences, Engineering, Social Sciences, and Humanities have weak participation in OA and attribute this to the limited efficacy of "NSERC, FRQ-NT and SSHRC mandates" (Paquet, van Bellen, and Larivière 2022).

Studies have confirmed that authors sometimes self-archive years or decades after publication, perhaps due to forgetfulness or newly acquired awareness of the advantages of OA (Larivière and Sugimoto 2018; Piwowar et al. 2018). There is also a lack of information provided by publishers, as investigated by Laakso (2014). Arendt, Peacemaker, and Miller (2019) found that many "free access" articles available through online sources, such as Google Scholar or academic social networking sites, are not compliant with publisher policies, and some are posted without the authors' permission. In this case, lack of awareness resulted in action that may violate publisher or copyright agreements which can be detrimental to OA efforts. Holter (2020) similarly identified contributing factors to low deposit rates, such as lack of knowledge of copyright, technological barriers due to the archiving systems, competing institutional and individual incentives, and confusion over mandates.

Methods

Publication data

We used a relational database version of OpenAlex hosted by the Maritime Institute for Science, Technology, and Society (MISTS) to collect all journal articles published between 2016 and 2021 with at least one author affiliated with a Canadian U15 university. The benefit of using an open database compared with a subscription database, such as Web of Science (WoS), is that it enables our research to be reproducible by anyone at no cost. Unlike WoS and Scopus, which index works from a highly curated list of journals, OpenAlex indexes works not included in WoS or Scopus and is updated daily with data from Crossref, PubMed, institutional, and disciplinary databases (Priem, Piwowar, and Orr 2022), so this should provide a more accurate view of IR usage. A limitation of OpenAlex is that document types are not granular enough to distinguish peer-reviewed research articles and reviews from other materials like editorials or letters to the editor, which are all encompassed in the "journal article" document type. Since research articles and reviews are likely to contain more references than other document types and to have a Digital Object Identifier (DOI), we limited our dataset to works with a DOI citing at least ten other OpenAlex works to mitigate this limitation. Our dataset thus constitutes a convenience sample for comparison purposes, and the numbers provided are not meant to be understood as absolute measures of the U15 universities' research output.

University	OpenAlex identifier	Total publications
Dalhousie University	https://openalex.org/I129902397	7,350
McGill University	https://openalex.org/I5023651	18,483
McMaster University	https://openalex.org/I98251732	13,115
Queen's University	https://openalex.org/I4210096394	7,934
Université Laval	https://openalex.org/I43406934	9,020
University of Alberta	https://openalex.org/I154425047	19,990
University of British Columbia	https://openalex.org/I141945490	25,787
University of Calgary	https://openalex.org/I168635309	14,223
University of Manitoba	https://openalex.org/I46247651	8,117
University of Saskatchewan	https://openalex.org/I32625721	12,286
Université de Montréal	https://openalex.org/I70931966	12,142

University of Ottawa	https://openalex.org/I153718931	6,812
University of Toronto	https://openalex.org/I185261750	37,020
University of Waterloo	https://openalex.org/I151746483	10,634
Western University	https://openalex.org/I125749732	12,472
Combined		180,637

Table 1: The number of works included in our study for each Canadian U15 university.

Field classification

Following Rivest, Vignola-Gagné, and Archambault (2021), we used the Science-Metrix classification of scientific journals (Archambault, Beauchesne, and Caruso 2011) to assign a discipline to journals. Despite covering only 15,000 journals, the classification is suitable for our purpose and has the advantage of being freely accessible. Papers in journals either not found or in the "article-level classification" category of the Science-Metrix classification were classified based on the discipline of the journals cited in the papers. For example, a paper citing seven publications in Chemistry journals and five in Physics journals was assigned to Chemistry. In case of a tie, the paper was assigned to both disciplines. Table 2 presents the number of papers assigned to each of the six larger disciplines of the classification during each step of the process.

Domains	**Number of publications based on publishing journal**	**Number of publications based on cited domains**	**Total**
Applied Sciences	30,857	3,111	33,968
Arts & Humanities	2,003	445	2,448
Economics & Social Sciences	9,527	2,171	11,698
Health Sciences	86,298	11,931	98,229
Natural Sciences	31,417	4,795	36,212
Unknown	-	-	44

Table 2: Number of papers assigned to six large disciplines.

Institutional repositories

The IR names and URLs were manually retrieved. The IRs featured in this paper seek to archive the various types of publications produced by faculty, staff, and students, including journal publications as well as theses and dissertations. Table 2 presents the list of IRs included in the study.

University	Repository name	Repository URL
Dalhousie University	DalSpace	https://dalspace.library.dal.ca/
McGill University	eScholarship@McGill	https://escholarship.mcgill.ca/
McMaster University	MacSphere	https://macsphere.mcmaster.ca/
Queen's University	Qspace	https://qspace.library.queensu.ca/
Université Laval	CorpusUL	https://corpus.ulaval.ca/
University of Alberta	ERA	https://era.library.ualberta.ca/
University of British Columbia	cIRcle	https://circle.ubc.ca/
University of Calgary	PRISM	https://prism.ucalgary.ca/
University of Manitoba	Mspace	https://mspace.lib.umanitoba.ca/
Université de Montréal	Papyrus	https://papyrus.bib.umontreal.ca/
University of Ottawa	uO Research	https://ruor.uottawa.ca/
University of Saskatchewan	HARVEST	https://harvest.usask.ca/
University of Toronto	Tspace	https://tspace.library.utoronto.ca/
University of Waterloo	UWSpace	https://uwspace.uwaterloo.ca/
Western University	Scholarship @ Western	https://ir.lib.uwo.ca/

Table 3: U15 institutions and their respective institutional repositories.

OA status and locations

We used the Unpaywall API to obtain the OA status and locations of the works in our dataset. We then checked whether the IR of the institution was listed as one of the OA locations by searching for the repository URL in the URL field of the OA Location object of the Unpaywall data schema. We also used an OAI-PMH-enabled API to harvest all records from each repository. Titles of articles were matched using a fuzzy matching algorithm. Results with low thresholds were manually checked and matched to the OpenAlex data.

Institutional Open Access policies

In July 2022, we manually searched the university websites to retrieve institutional OA policies or statements approved by their respective University Senate. These were then coded according to five criteria: 1) Policy type (whether deposit in the IR is mandated, suggested, or not mentioned), 2) manuscript version (the deposit of which version of the manuscript is mandated or suggested), 3) timing of the manuscript deposit in the IR, and 4) if the policy specifies the use of the IR for deposit. We have excluded signatories to other declarations.

We used an iterative single-coder method for coding as the distinctions were easy to identify by agreement with the senior researcher and other authors. The lead author analyzed the results, and these were discussed with the senior researcher and one of the co-authors to reduce subjective bias or omissions. We followed Fruin & Sutton's distinction of policy versus statement, "an institutional policy specifically articulates" requirements, whereas statements "have less policy-like features and explicit expectations" (Fruin and Sutton 2016). For consideration as a policy, the document's title must include the word *policy* and have been issued by the University Senate or equivalent governing body. Similarly, statements must include the word *statement* in the title and be approved by the University Senate. We label policies where requirements are clearly specified as *mandated*. Policies where specific

requirements are not clearly identified, such as manuscript version and timing, are labelled as *suggested*. In this case, *suggested* is the same as request or encouragement as defined by Suber (2012). The *manuscript version* and *timing* coding are taken verbatim from the policy. *IR deposition* is determined by if and how the policy specifies or recommends using the IR for deposition.

To account for policies that may not be on university websites, missed in our search, or been published after Tummon and Desmeules's (2022) study, we contacted the scholarly communications librarians (or role nearest to this) by email at each university in January 2023. The librarians' confirmation of policy presence were included in our analysis of institutional OA policies.

Journal Open Access policies

On July 20, 2022, we used the Sherpa Romeo API to collect data on the journal's self-archiving policies. Sherpa data provides information on the different OA pathways possible with the journal. We collected the following elements of information from Sherpa Romeo: 1) Whether self-archiving is allowed, 2) which manuscript version can be self-archived in an IR, and 3) the embargo period for archiving in an IR.

Summary of variables and data sources

Table 4 presents a summary of the variables used in our study and where the data was collected.

Category	Variable	Description	Source
Publication	Paper ID	Unique identifier of the publication in the OpenAlex.	OpenAlex
	DOI	Digital Object Identifier of the publication.	OpenAlex
	Publication year	Year of publication in the journal.	OpenAlex
	Discipline	Science Metrix Classification	OpenAlex + Science Metrix
	University	U15 institution of the author	OpenAlex
Institutional Repository	Repository name	Name of the institutional repository	University website
	Repository URL	URL of the institutional repository	University website
OA status and locations	OA status	Whether a publication is accessible in OA	Unpaywall
	Own institutional repository		Unpaywall + OAI-PMH API
	Version		Unpaywall
Journal policy	Green OA allowed	Key:value pair from JSON data	Sherpa Romeo
	IR deposit allowed	Key:value pair from JSON data	Sherpa Romeo
	IR version allowed	Key:value pair from JSON data	Sherpa Romeo
	IR version embargo	Key:value pair from JSON data	Sherpa Romeo
Institutional policy	Policy exists	Manually derived	University website
	Policy type	Manually derived	University website
	Version required	Manually derived	University website

	Timing	Manually derived	University website
	IR position	Manually derived	University website

Table 4: Variables and data sources summary

Results

Institutional OA policies

The few policies from the U15 Group defer to the funder policies, such as the *Tri-Agency Open Access Policy on Publications* (TOAPP) (Government of Canada 2016) and the *Fonds de Recherche du Québec Open Access Policy for the Dissemination of Research* (FRQOAP) (Politique de diffusion en libre accès des Fonds de recherche du Québec 2019) where funder requirements already specify an author's responsibility to satisfy publicly funded projects. Other funder policies (e.g., NIH) are mentioned in the literature, typically within OERs provided by institutional libraries. Except for three universities, all other members of the U15 do not have OA policies or statements that meet our inclusion criteria and instead defer to funding agencies for OA requirements on their websites, most commonly referring to the TOAPP. Unsurprisingly, these universities rely on OERs provided by their respective libraries to provide information on OA, their IR, and interpretations of funder policies. Table 5 shows the policy type, the manuscript version that should be deposited when the manuscript should be deposited, and if the IR is specified.

Organization	Policy Type	Manuscript version	Timing	IR position
Dalhousie University	No policy	-	-	-
McGill University	No policy	-	-	-
McMaster University	No policy	-	-	-
Queen's University	No policy	-	-	-
Université de Montréal	Mandated	Final version of the accepted scholarly publication	As soon as it is accepted and at the latest on the day of its publication	Describes member and UdeM obligations for use of the IR and subsequent dissemination
Université Laval	Suggested	Accepted version	At time of acceptance	Encourages members to contribute to the IR, with copyright arrangements for dissemination
University of Alberta	No policy	-	-	-
University of British Columbia	Suggested (statement)	Refereed and non-refereed work	Defer to publisher	Encourages members to contribute to the IR, with copyright arrangements for dissemination
University of Calgary	No policy	-	-	-
University of Manitoba	No policy	-	-	-
University of Ottawa	No policy	-	-	-
University of Saskatchewan	No policy	-	-	-
University of Toronto	No policy	-	-	-
University of Waterloo	No policy	-	-	-
Western University	No policy	-	-	-

Table 5: The collected and synthesized open access policies for each of the U15 institutions.

We found only two institutional policies and one statement that specifies the responsibilities or expectations of community members. The Open Access Policy at the Université de Montréal is the only mandate. All authors must upload their work to the IR within 12 months of publication (*Libre accès aux publications savantes13*, 2019). The Université Laval policy encourages members of the university to "consider the objectives of the [Tri-Council] Policy" (*Politique sur le libre accès aux publications des résultats de recherche à l'Université Laval* 2017) for any publication, funded or not. Authors are also encouraged to retain their copyright to enable free distribution. The policy specifies the manuscript version as advice to "deposit research results at the time they are accepted for publication" (*Politique sur le libre accès aux publications des résultats de recherche à l'Université Laval* 2017). The University of British Columbia

position statement encourages faculty members to deposit their work in the IR with timing requirements and deferral to the publisher requirements (Open Access Position Statement 2013).

Three universities report having draft policies currently under review. The University of Manitoba's was not distributable, and the unpublished draft from Dalhousie University was under review as a suggested policy type with no definition for types of work or a timeframe for deposition (P. Riddle, personal communication, Jan 9 2023). Western University's policy was still a draft as of its release in 2021, though it has only been released for discussion and has not been approved by the University Senate. The draft appears to be a suggested type, specifying deposition in the IR as early as possible and permitting limiting publication access to meet publisher, patenting, or funding requirements (Provost's Task Force on Open Access and Scholarly Communication 2021).

Journal policies

From 16,199 journal ISSN-L numbers, we retrieved 55,829 policies, with 3,980 returning empty JSON data or no policy information, leaving 51,849 policies to analyze. All of these had locations specified, but only 11,264 had embargo periods specified. A total of 25,005 policies (15,400 journals) included IRs as possible deposit locations, but only 8,996 have a location, embargo period, and OA fee data. Table 6 reports the number of journals allowing different versions of the manuscript to be self-archived in IRs as well as the embargo period.

Embargo (months)	Submitted		Accepted		Published		Total	
	N	%	N	%	N	%	N	%
0	88	0.98	128	1.42	18	0.20	234	2.60
1	0	0.00	0	0.00	3	0.03	3	0.03
3	0	0.00	1	0.01	6	0.07	7	0.08
6	0	0.00	339	3.77	59, 2*	0.66	400	4.45
12	3	0.03	5,912	65.74	160, 63*	1.78	6,138	68.25
18	1	0.01	883	9.82	2	0.02	886	9.85
24	1	0.01	1,278	14.21	0	0.00	1,279	14.22
36	0	0.00	46	0.51	0	0.00	46	0.51
Total							8,996	

* Has OA fee requirements

Table 6: Embargo period length for journal policies that specify IR as a location, sorted by embargo period and version permitted for deposition. Percentages are of the total N journals.

OA publishing and self-archiving

Table 7 shows that overall OA is around 50% in most universities, with Green OA making up most of the OA, which is consistent with past studies. However, the percentage of those Green OA found in IRs is surprisingly low, with a maximum of 10.7% and a low of 0.5%, and a mean of 4.2% using combined scores. A secondary investigation using publication records extracted directly from the IRs using OAI-PMH suggests that these numbers are accurate.

Institution	Works	Open access (%)		Institutional repository (%)			Version of paper available in IR (Unpaywall only) (%)		
		All	Green	Unpaywall	OAI-PMH	Combined	Submitted	Accepted	Published
Dalhousie University	7,350	55.3	43.8	0.0	1.1	1.1	0.0	0.0	0.0
McGill University	18,483	58.1	48.3	0.0	4.0	4.0	0.0	0.0	0.0
McMaster University	13,115	55.3	44.5	0.4	1.0	1.1	0.3	0.0	0.1
Queens University	7,934	53.4	43.7	2.5	0.0	2.5	1.3	0.5	0.7
Université Laval	9,020	58.6	47.1	4.4	5.8	6.8	0.1	2.5	1.8
University of Alberta	19,990	47.1	36.3	0.0	1.4	1.4	0.0	0.0	0.0
University of British Columbia	25,787	55.8	45.6	0.0	5.1	5.1	0.0	0.0	0.0
University of Calgary	14,223	54.5	43.6	5.3	4.9	5.8	0.5	0.4	4.4
University of Manitoba	8,117	55.3	44.1	5.3	4.1	5.4	0.5	0.2	4.6
Université de Montréal	12,286	59.5	49.4	2.3	2.2	2.9	1.4	0.2	0.7
University of Ottawa	12,142	53.4	42.1	0.0	5.2	5.2	0.0	0.0	0.0
University of Saskatchewan	6,812	48.6	37.4	0.1	0.5	0.5	0.1	0.0	0.1
University of Toronto	37,020	56.6	46.5	2.7	5.5	6.0	0.2	0.1	2.4
University of Waterloo	10,634	46.4	37.1	3.6	3.6	4.0	0.8	1.1	1.6
Western University	12,472	50.7	41.4	0.0	10.7	10.7	0.0	0.0	0.0

Table 7: Number of publications and OA status for OpenAlex works by the Canadian U15 universities. The percentages shown are of the number of works attributed to each university.

Table 8 shows disciplinary differences in OA publishing and self-archiving practices across domains. Health and Natural Sciences publish in OA and self-archive, but the use of IRs remains limited. However, when considering the overall use of Green OA, the Applied Sciences, Economics, and Social Sciences seem to make relatively higher use of the IRs for self-archiving.

Discipline	Works	Open access (%)		Institutional repository (%)			Version of paper available in IR (Unpaywall data)		
		All	Green	Unpaywall	OAI-PMH	Combined	Submitted	Accepted	Published
Applied Sciences	33,831	33.8	23.1	1.9	3.8	4.2	0.4	0.5	1.0
Arts & Humanities	2,448	37.5	21.0	1.3	2.2	2.5	0.3	0.3	0.7
Economic & Social Sciences	11,694	34.5	20.7	1.8	3.7	4.2	0.8	0.4	0.6
Health Sciences	98,209	61.5	51.6	4.0	5.5	6.0	0.3	0.2	3.5
Natural Sciences	35,260	53.8	44.8	1.7	3.3	3.8	0.4	0.6	0.7

Table 8: Number of publications and OA status by domain, sorted alphabetically.

Discussion

OA publishing and the use of IR usage

Our findings show the percentage of OA items consistent with prior studies, with most U15 institutions at around 50% overall OA and 40% Green OA. The proportions of Gold to Green OA are similar to those found in a recent study on Canadian OA (Paquet, van Bellen, and Larivière 2022). We observed the highest Green OA deposits in IR in Heath confirming Paquet, van Bellen, and Larivière's (2022) study. Natural Sciences had the next highest proportion of Green OA, followed by Applied Sciences, Arts & Humanities, and Economics & Social Sciences. This order contrasts with Paquet, van Bellen, and Larivière's (2022) finding that the highest Green OA rates were in Social Sciences and Humanities and less in Natural Sciences and Engineering. Those differences could be attributed to the different data sources, inclusion criteria, and disciplinary classification.

Despite a generally high adoption of Green OA, our results suggest an underuse of IRs for self-archiving peer-reviewed journal articles, which aligns with previous findings reported by Creaser et al. (2010). This may be due to authors choosing to deposit an OA version in subject repositories or academic social networking sites believed to provide more visibility and allow researchers to track engagement (Aguillo 2018). It may also be related to the multiplication of repositories over time, as documented by Sherpa's global Directory of Open Access Repositories (https://v2.sherpa.ac.uk/opendoar/) and the Registry of Open Access Repositories (http://roar.eprints.org/). Furthermore, the lack of reward, perceived effort (Fecher et al. 2017; Zuiderwijk, Shinde, and Jeng 2020), embargoes, data sharing standards, and perceived complexity of IR user interfaces (Zuiderwijk, Shinde, and Jeng 2020) have also been discussed as factors that may inhibit researchers from using IRs. Another contributing factor to the generally low use of IRs observed may be that U15 universities do not have strong OA policies that go beyond the funding agencies' requirements and do not require researchers to use their IRs. Our searches and requests for information from scholarly communication librarians indicated there are

statements at department or library levels that may also be a factor in OA uptake and the use of IRs, as suggested by Tummon and Desmeules (2022).

It should be noted that our study only investigated the usage of IRs for self-archiving of peer-reviewed journal articles, which is not the only use of IRs where many other types of publications (e.g., dissertations and theses, educational material, and presentations) can be found. Whether IRs are a popular venue to host such material is not addressed in our study, but our findings suggest that they are not the preferred self-archiving venue of U15 researchers. Indeed, our findings do not provide details on the Green OA venue used by researchers but indicate that the vast majority of Green OA publications are not found in the IRs. This is the case even at Université de Montréal, where the policy mandates using the IR for self-archiving, which raises questions about the general effectiveness of OA policies for influencing researcher behaviour.

Institutional OA policies

Our investigation of institutional OA policies showed most institutions in the U15 do not have a university-wide OA policy. Institutions with policies are at the top for Green OA by a small margin, but there is insufficient data to attribute this to policy presence or effectiveness. While collecting data on institutional-level OA policies, we found, or were informed by a university librarian, about department-level OA policies and statements of commitment. Unlike in the United States, where lack of a centralized federal system presents an obstacle to more efficient university policies (Mering 2020), the U15 can use Tri-Council and the FRQ as a lever to increase self-archiving in IRs. As the FRQ changed to the Plan S model in March 2023, this study may be helpful as a prior data point in determining the future effectiveness of IR deposition of Green OA over more extended periods to address the limitations of a short time frame during recent policy implementations and change in Canada. Ultimately, the adoption of OA in general and particularly the use of IRs for self-archiving is a behavioural change problem, and future research may shed light on the effectiveness of these policies.

Future research directions in IRs and OA might also investigate what IRs are used for and how much of the IR is occupied by OA resources beyond peer-reviewed articles. We were also informed of university OA policy drafts in progress, covered in our results but not in the table, as they did not meet our inclusion criteria. These may provide an opportunity to investigate debates or current concerns from faculty and staff regarding their adoption. We also identified during our data collection phase that libraries provide a variety of information on OA. While some institutions do not have university-wide OA policies, some libraries and departments have statements. The University of Alberta Library has a statement of principle as a commitment to open and sustainable scholarly communication acknowledging the Vienna Principles ("Scholarly Communications Statement of Principles" 2019). McMaster University Library includes a note on its OA information page that the "McMaster University Senate recently passed a motion to sign the Berlin Declaration encouraging McMaster researchers to make their work open access" ("Open Access" n.d.). McGill University has three departments with their own statements or policies, such as the McGill Libraries ("Open Access Statement for McGill University Library" n.d.), the Douglas Research Center (Douglas Research

Center 2021), and the Montréal Neurological Institute-Hospital ("Open Science Principles" n.d.). The University of Saskatchewan Library has a commitment statement that applies to librarians and archivists to publish OA in the IR and encourage and support other researchers ("Open Access Commitment" 2010). Queen's University also has an OA policy that applies to their academic staff with a deposit in the IR as soon as possible in recognition of publisher embargo periods (*Queen's University Open Access Policy for Librarians and Archivists* 2013). The University of Ottawa Library also has an OA-suggested policy that applies to staff to make the 'best possible effort' to publish OA and indicate the IR as a preferred location ("Open Access Policy" 2018). There is an opportunity to examine department-level OA policies for their impact on IR usage as an alternative to institution-wide policies. Such research might be advantageous for other departments considering their own OA policy or statement of commitment, particularly toward understanding the infrastructure required to sustain Green OA contributions.

Journal OA policies

For the 16% of the journal OA policies returned that had complete information, we observed 75.4% with embargoes of 12 months or less. Of the three paper versions allowed to be deposited (submitted, accepted, and published), the majority in all embargo periods is the accepted version, followed by the published version. However, this is heavily skewed toward the accepted version. Of the 75.4% with an embargo of 12 months or less, 69.9% are the accepted version. This means that authors can self-archive either their submitted or accepted paper within a repository for OA. We also found 24.6% of OA journal policies with IR and embargo information had an embargo that exceeded 12 months. Though excluded from our analysis, we did find embargoes as high as 60 months, confirming prior research by Laakso (2014). However, we did not include these as the publisher information was incomplete. Despite structured metadata in Sherpa ROMEO, incompleteness of policy details might be attributed to a lack of policy standardization across or within publishers. While some repositories such as PubMed (https://pubmed.ncbi.nlm.nih.gov/) have a mechanism that automatically renders articles available after the embargo period, with no extra effort provided by the authors, these types of mechanisms are still lacking in U15 IRs, to the best of our knowledge. The implications for journal OA embargoes over 12 months are that they put authors in a position where there are conflicting requirements between funders and publishers or increase the possibility of forgetting about moving articles to an OA repository after the embargo expires. If institutions want to increase IR usage or the proportion of Green OA, more visibility of publisher policies is needed, particularly with regard to barriers for authors. While authors are stuck between binding contracts between publishers and funders, strong mandates with no opt-out for deposition may relieve authors of the burden of negotiating publisher policy requirements.

Conclusion

We present our research questions with explicit answers based on our analysis of our data collected from OpenAlex on peer-reviewed works by authors affiliated with the Canadian U15 between 2016 and 2021. The purpose of our research was to provide an

overview of the uptake of OA in Canadian U15 institutions focused on understanding the usage of their respective IRs. We also sought to understand relationships between characteristics of university-wide OA policies, publisher policies, and IR usage for OA contributions. Lastly, we conclude with recommendations for those considering crafting policies or considering how they might remove barriers to IR usage.

RQ 1: What OA policies are in place in the U15, and is there a relationship between policy types and institutional repository usage?

Two Canadian U15 have institutional OA policies: the Université de Montréal's mandate and the Université Laval's suggested policy. The University of British Columbia implemented an OA statement that suggests OA contributions. Western University, Dalhousie University, and the University of Manitoba have drafts yet to be approved. The Université de Montréal has a mandate and the highest OA counts, including Green and Gold OA. Université Laval and Western University have the highest IR usage, though only Université Laval has an institutional OA policy in effect. However, despite the Université de Montréal's high OA contribution to date, it has low IR usage despite its mandate. Due to the low number of policies and overall low IR usage, a relationship between policy types and IR usage is not evident.

RQ2: What are the characteristics of the OA policies of journals in which the U15 publishes in terms of self-archiving in institutional repositories, the manuscript version allowed for deposit, and embargo periods?

We analyzed over 55,000 journal policies from over 16,000 journals used by authors affiliated with the U15. Only 16% of journal policies contained complete policy information, with 24.6% having embargoes exceeding 12 months. The remaining majority (69.9%) permit archiving the accepted version in an IR with an embargo of 12 months or less. Based on this, our results suggest a lower use of Green OA by U15 researchers than is permitted by journal policies with complete policy information.

RQ3: What percentage of the research output from the U15 is available as OA and in the institutional repositories?

Our findings show the percentage of OA items consistent with prior studies, with most of the U15 institutions, close to 50% overall (46.4 – 59.5%, 48.7 mean) and 40% Green OA (36.3 – 49.4%, 43.4 mean). The proportions of Gold to Green OA are similar when compared to a recent study on Canadian OA (Paquet, van Bellen, and Larivière 2022), which also investigated OA by authors with Canadian university affiliations. However, we find a low use of IRs with between 0.5% and 10.7% (4.2 mean) of peer-reviewed articles deposited, which is in line with prior research finding a decrease in the use of IRs observed by Aleixandre-Benavent et al. (2019).

RQ4: Are there disciplinary differences in OA publishing and IR usage?

In line with prior research (Larivière and Sugimoto 2018; Paquet, van Bellen, and Larivière 2022), we find differences in OA publishing and self-archiving across domains, with Health and Natural Sciences contributing the most to Green OA, followed by Applied Sciences, Arts & Humanities, and lastly Economics & Social Sciences. Health

contributes the most to OA (61.5% overall and 51.6% Green OA) and IR usage (6.0%). Applied Sciences (4.2%) and Economics & Social Sciences (4.2%) seem to make slightly higher use of the IRs for self-archiving than Natural Science or Arts & Humanities.

Recommendations

Some recommendations can be drawn from our findings. Adopting strong policies that require (rather than encourage) OA publishing and self-archiving may, if enforced, generally increase OA practices. This is supported by the finding that the Université de Montréal, the only university with an OA mandate, has the highest proportion of OA publications overall and in Green OA. However, IRs appear not to be the tool researchers use to self-archive their work, with very low percentages across the board. Whether or not it would be desirable for IRs to become the main venue for self-archiving in U15 institutions is a question that we believe needs to be addressed before developing and implementing strategies to increase IR usage. If such a need is identified, then adopting a strong policy that mandates all researchers to deposit their work in their IR, such as the one pioneered by the University of Liège, Belgium and based on the conditions recommended by Vincent-Lamarre et al. (2016), could be effective. Other strategies to increase IR usage could include assessing their usability to eliminate barriers to their use or developing self-archiving services in libraries that could, for example, automate the self-archiving process rather than rely on researchers to deposit their work themselves. Acknowledging the disciplinary differences in OA practice and scholarly communication practices more generally may be helpful when developing institutional or departmental OA policies or strategies to increase OA participation or IR usage.

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About the Authors

Poppy Riddle is a lecturer and an interdisciplinary Ph.D. student at Dalhousie University researching exploratory search systems and scholarly communication.

Marc-André Simard is a doctoral student at the École de bibliothéconomie et des sciences de l'information at Université de Montréal.

Pallavi Gone is a lecturer and interdisciplinary Ph.D. candidate at Dalhousie University whose research area is machine learning, natural language processing, and social media.

Vinson Li is a research assistant at Dalhousie University and Librarian Educator at Nova Scotia Health, researching bibliometrics, health science librarianship, and combatting misinformation.

Philippe Mongeon is an associate professor at the Department of Information Science at the Faculty of Management of Dalhousie University, director of the Quantitative Science Studies Lab, and an associate member of the Centre interuniversitaire de recherche sur la science et la technologie (CIRST).

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