Research Analysis: A World Data System and Canadian CoreTrustSeal Cohort Needs Assessment

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Abstract

From July 2022 to December 2022, the World Data System (WDS) International Technology (ITO) and International Program (IPO) Offices conducted a review of strategic plans and technical roadmaps of all current WDS members and the set of Canadian repositories that participated in the Digital Research Alliance of Canada's CoreTrustSeal Certification Support and Funding Pilot[v] (Digital Research Alliance of Canada, 2022). In this paper, we describe how a new organizational assessment method was designed and utilized to identify the needs and challenges faced by the WDS and Canadian CTS Pilot members. Our method relied on reviewing public-facing documentation provided by the repositories, with a priority on strategic plans and technical road maps. In total, we reviewed 95 sources of information, including 33 strategic plans and 3 technical roadmaps describing a total of 95 out of the original 147 target organizations. In this paper, we also describe our assessment tool and the overarching challenges and goals we identified through the usage of this tool. Finally, we will describe the limitations of our methodology and provide recommendations from the World Data System on how best to assist the WDS members and the cohort of Canadian data repositories based on our findings.

Keywords

World Data System, CoreTrustSeal, strategic plans, technical roadmaps, needs assessment, data repositories

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1. Introduction

The World Data System (WDS), an interdisciplinary body of the International Science Council, is a global consortium of data repositories and affiliated organizations. The WDS grew out of the World Data Centers, which were established in 1957 largely in response to the need to store large amounts of data created during the International Polar and Geophysical years (1932 and 1957, respectively). Today, the WDS is a consortium of over 120 data distribution centers and related entities in four different membership classes: regular, network, partner, and associate. WDS members are charged with

responsible data stewardship and analysis, serving a wide range of research domains in over 29 countries.

The overall objectives of WDS are defined in its Constitution[vi] as follows:

1. Enable universal and equitable access to quality-assured scientific data, data services, products and information
2. Promote long-term data stewardship
3. Foster compliance to agreed-upon data standards and conventions
4. Provide mechanisms to facilitate and improve data access

Operationally, activities of the WDS are conducted under the leadership of two complementary and coordinated offices: the World Data System International Program Office (WDS-IPO) hosted at the University of Tennessee - Oak Ridge Innovation Institute and the World Data System International Technology Office (WDS-ITO) hosted by Ocean Networks Canada at the University of Victoria. This report details how these offices worked together to test out a new method of needs assessment for WDS members and a cohort of Canadian data repositories.

As part of our commitment to understanding the current state of the WDS membership, a needs assessment was conducted centered on a systematic review of the existing technical roadmaps and strategic plans of current WDS member repositories, as well as the current set of repositories participating in the Digital Research Alliance of Canada's CoreTrustSeal Certification Support and Funding Pilot (Digital Research Alliance of Canada, 2022). The latter set of repositories was included in this review in part because any repository that receives CoreTrustSeal certification is eligible to apply for WDS membership, and identification of their needs helps the WDS create targeted programs that will encourage new applications.

The goal of this assessment was, first and foremost, to identify the needs and challenges faced by WDS members and Canadian repositories. The outcome of this activity enables the WDS to identify ways in which they can be of service to these member repositories, such as providing insight with respect to creating guiding architecture plans for integrating data repositories with other global research services or helping prioritize funding streams to projects that support common infrastructure needs across organizations. Additional goals for this assessment include expanding WDS member profiles, identifying WDS datasets that support polar research, and identifying which members have satisfied CoreTrustSeal requirements.

Ultimately, our priority was to assess whether a comprehensive needs assessment could be completed from a review of public-facing strategic plans. Previous studies, such as those by Ashiq et al. and Thoegersen & Borlund, utilized key search parameters to identify relevant documentation on their research topics of Research Data Management (RDM) practices and researcher attitudes toward data sharing (Ashiq et al., 2020; Thoegersen & Borlund, 2021). While more traditional needs assessments and

repository surveys consisted of a questionnaire that was then sent to a target audience (Joo & Peters, 2019; Khan et al., 2021; Payne & Urquidi Diaz, 2020), we sought to investigate whether a review of strategic plans would allow us to assess the needs and challenges of the WDS and Canadian CTS Cohort without the need to send a survey to each member, mitigating the administrative burden for the member organization. The core of strategic planning, as stated by Bryson, is defined as "the identification and resolution of strategic issues," ultimately yielding goals, policies and plans to address an organization's strategic challenges (Bryson, 2018; George et al., 2019). Therefore, based on this definition, we focused our needs assessment around the review of strategic plans.

2. Methods

We conducted a multi-staged process to create the instrument that guided our review of the target repositories public facing documentation, beginning with generating an initial list of characteristics we wanted to capture from each document. This stage of instrument development was informed by both the current WDS action plan and by reviewing a series of strategic plans from the WDS members. The initial list of characteristics covered areas such as mission and vision statements, long-term goals and strategic priorities, guiding principles, references to polar data or resources, funding sources and known challenges and obstacles encountered, among others.

The next phase of instrument development was informed by the criteria under development by the Global Biodata Coalition (GBC)[vii] (Global Biodata Coalition, 2022; Durinx et al., 2017). The GBC is an initiative designed to support funders by identifying and prioritizing fundamental data resources, referred to as Core Biodata Resources, that should be maintained as part of the worldwide life science infrastructure. The criteria used to evaluate and assess these core resources was first piloted in Europe as a set of qualitative and quantitative indicators and processes for identifying ELIXIR Core Data Resources (Global Biodata Coalition, 2022; Durinx et al., 2017). We examined the 2022 version of the Global Core Biodata Resources: Concept and Selection Process[viii] and extracted criteria that could be applied to our review of WDS and Canadian CTS candidate repositories (Global Biodata Coalition, 2022). Our initial list of characteristics was augmented with criteria from the GBC. In this phase, we included quantitative questions in the form of yes/no responses, such as "does the organization reviewed refer to a mission statement?" as well as qualitative responses recording more detailed information, such as the entire mission statement for the reviewed organization. Together, our initial criteria, augmented with the GBC criteria, constitute the reviewer instrument. The instrument allowed multiple researchers to review strategic plans and roadmaps simultaneously, with all the responses being directed to a standardized spreadsheet. We implemented the instrument using google forms.

We tested the instrument to ensure that responses created within the instrument fed correctly into the designated spreadsheet and all results were saved to a collective workspace. The second and primary reason for testing was to ensure that the information requested in the reviewer instrument was robust enough to successfully capture all the necessary data to achieve the defined objectives. We used five strategic plans for testing the instrument. Three separate researchers conducted test reviews using the five strategic plans. Feedback generated through the testing process showed the need for further

questions to adequately capture sufficient information about the common themes, issues, and goals faced by the WDS and Canadian Cohort repositories. Additional questions were added, including questions related to repository partnerships with Indigenous groups; references to diversity, equity and inclusion; references to sustainability and long-term funding sources; and any references to the repository's plans for obtaining new partnerships for research and funding. Following the culmination of testing, the reviewer instrument was finalized. The entire reviewer instrument can be found in the World Data System and Canadian CoreTrustSeal Cohort Need Assessment: Reviewer Instrument and Supplemental Information (Lee et al., 2023).

2.1 Identification of Canadian Cohort and World Data System Members

The members of the WDS review team compiled a list of the organizations that went through the Digital Research Alliance of Canada's CoreTrustSeal Certification Support and Funding Pilot to form the Canadian CTS Cohort membership list (Digital Research Alliance of Canada, 2022). We included the Canadian CTS Cohort because these repositories are in the early stages of completing their CoreTrustSeal certification with the aid of our funder, Digital Research Data Alliance of Canada. Once they complete their CoreTrustSeal Certification, these repositories will be eligible to apply for WDS membership. The World Data System membership list[ix] was created by second author Sarah Gonzalez after an in-depth membership audit completed in May 2022. The membership list includes four classes of members: Regular members are data repositories that have achieved CoreTrustSeal certification, Network members are networks of certified repositories, and Partner and Associate member designations are assigned by WDS for organizations that support research data. The number of members as of December 2022 are:

- WDS Regular Members (84)
- WDS Network Members (10)
- WDS Partner Members (11)
- WDS Associate Members (20)

2.2 Collection of Strategic Plans/ Roadmaps and Other Documentation for Canadian CTS Cohort Members

The WDS review team made a good-faith effort to find the strategic plans and/or technical roadmaps for the Canadian Cohort. Unfortunately, we could not find their plans on their public-facing websites. Per our request, the lead of the Canadian Cohort Pilot program asked that these members send their strategic plans directly to the researchers by September 2022. As a result of this request, we received two strategic plans from the Canadian cohort. Investigation into additional public-facing documentation for the Canadian CTS Cohort, such as annual reports or data policies, yielded no results on their public-facing websites. Therefore, we assessed information on each cohort member from their organizational information on the re3data[x] website or directly from the cohort member's website as part of Phase two of the review process. Figure 1 shows the hierarchy that was used when collecting public-facing documentation and levels utilized for the Canadian CTS Cohort and the WDS members.

2.3 Collection of Strategic Plans/ Roadmaps and Other Documentation for WDS Members

We repeated the process of searching for strategic plans and/or technical roadmaps for the WDS members. Priority was placed on the collection of WDS members' strategic plans and/or technical roadmaps. However, other documentation, including annual reports or data policies, journal articles or other sources of documentation (fact sheets, statutes), were additionally pulled from public-facing websites where they existed. Additionally, CoreTrustSeal applications were pulled from the CoreTrustSeal (CTS) website[xi]. WDS requires that Regular members complete CTS certification but does not require CTS certification for other membership types. The researchers searched for strategic plans, roadmaps, or other documents published on each WDS member's website, but only in the case of the Canadian CTS Cohort were the actual websites themselves consulted as a form of information for assessment.

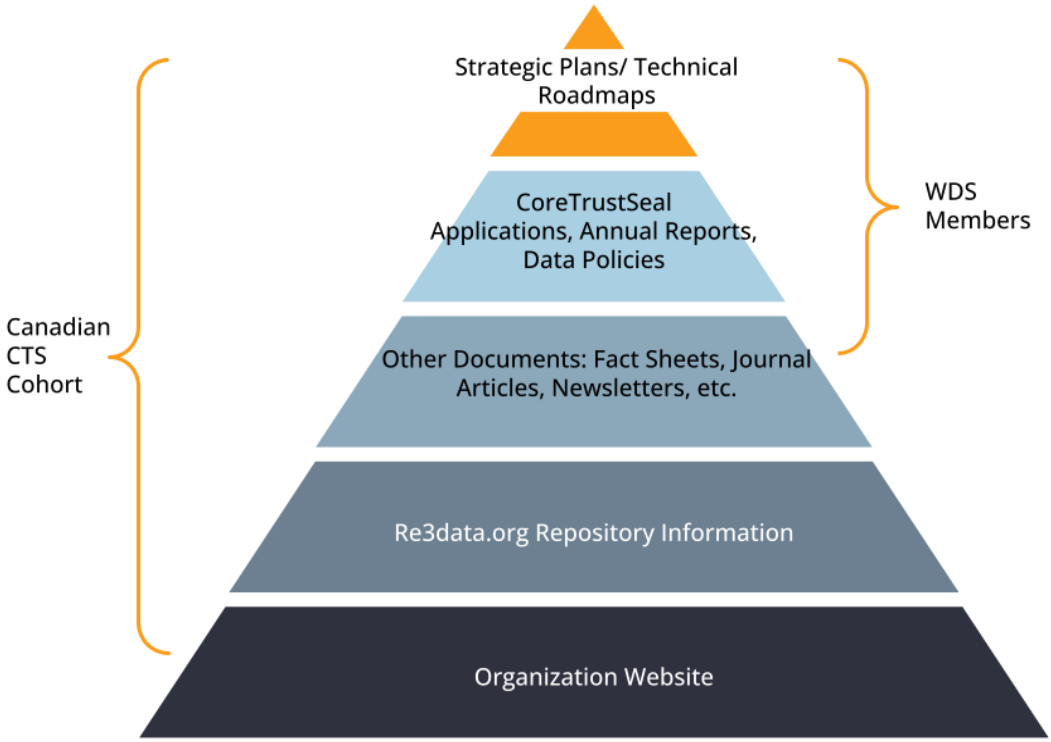

Figure 1. Hierarchy of documents that were prioritized in this assessment.

2.4 Documentation Review

Our review of the collected documents was conducted in two phases: first, a review of available strategic plans and technical roadmaps, followed by a review of additional documents that fell outside of the scope of strategic plans and technical roadmaps. Reviews of the collection of strategic plans commenced in October 2022. At the time of this writing (December 2022), each document has been reviewed once. During the testing process, feedback mentioned the presence of multiple questions that could indicate similar items, i.e., long-term goals, strategic priorities, activities, strategies employed, et cetera. The goal of including these items was to capture the terminology the organization used to find common themes. A degree of discretion was required on the reviewer's part to identify where specific information should be

recorded within the instrument. In our summary below, overarching themes from these multiple related questions have been synthesized to identify overlapping goals and themes of the organizations. An additional note is that the category of 'maybe' was included in our review to indicate where it was difficult to discern the relevancy of the information provided. An example of this is where an organization may reference an Indigenous group but not expand on how they are involved with the organization or in instances where the information was not clearly defined, such as in identifying long-term goals for the organization. In these instances, best discretion was used, and where there was doubt, a maybe was indicated instead of a yes. The instrument contains a final question where comments or additional feedback may be added by the reviewer. These comments included additional relevant information on the source of the assessment or any comments that the reviewer thought would be beneficial in the analysis of the data.

During the second phase of the review process, additional documents that fell outside the scope of strategic plans or technical roadmaps were assessed. This included documents such as CoreTrustSeal applications, annual reports, and data policies, among others. The decision was made on an individual basis for organizations that had multiple alternative documents, for example, an annual report and a data policy. The decision on which document to use was made by the researcher after determining which document contained the most relevant information based on the goals of this assessment.

2.5 Analysis

Ultimately, all collected documents were reviewed and summarized by a single reviewer, which minimized the amount of variance when reviewer discretion was necessary. The analysis and summarization of reviewer responses followed a straightforward approach, with the primary goal of identifying commonalities and differences between each of the WDS member types and the Canadian CoreTrustSeal Cohort. Responses were organized based on quantitative or numerical yes/no type answers and qualitative or long-form responses. Long-form answers were summarized where possible using a web-based text summarizing tool[xii]; additionally, word statistics[xiii] were also calculated to aid in identifying keywords or phrases that may help identify common themes. Responses were divided by WDS membership type. The intent behind this decision was the belief that when identifying goals, challenges, or needs, there would be commonalities within each membership type. In addition to these tools, we also created a more traditional researcher interpretation and summary of the literature where we identified the most relevant criteria and responses based on the goals of this assessment, the results of which can be found below.

3. Results

In this section, we provide the results of our assessment and discuss the common themes that emerged amongst all WDS and Canadian CTS Cohort members. We take full responsibility for any mistakes or unintentional mischaracterizations within this report, and therefore, we do not identify repositories by name. We begin by providing an overview of the organizations reviewed by summarizing the number of organizations, types of documents, domains (with particular attention paid to polar activities due to ongoing investments in this area by the WDS), and references to diversity, equity and inclusion, particularly in the context of Indigenous communities, for all organizations reviewed in aggregate. In

subsequent sub-sections, we break out our analysis by Canadian CTS Cohort and WDS member type. In the broadest view, across all member types, the two most significant concerns of data repositories were sustainability and creating effective partnerships with other entities in the research data space. Moreover, we suggest that more granular details of our findings could be made after additional consultation with and consent from each repository.

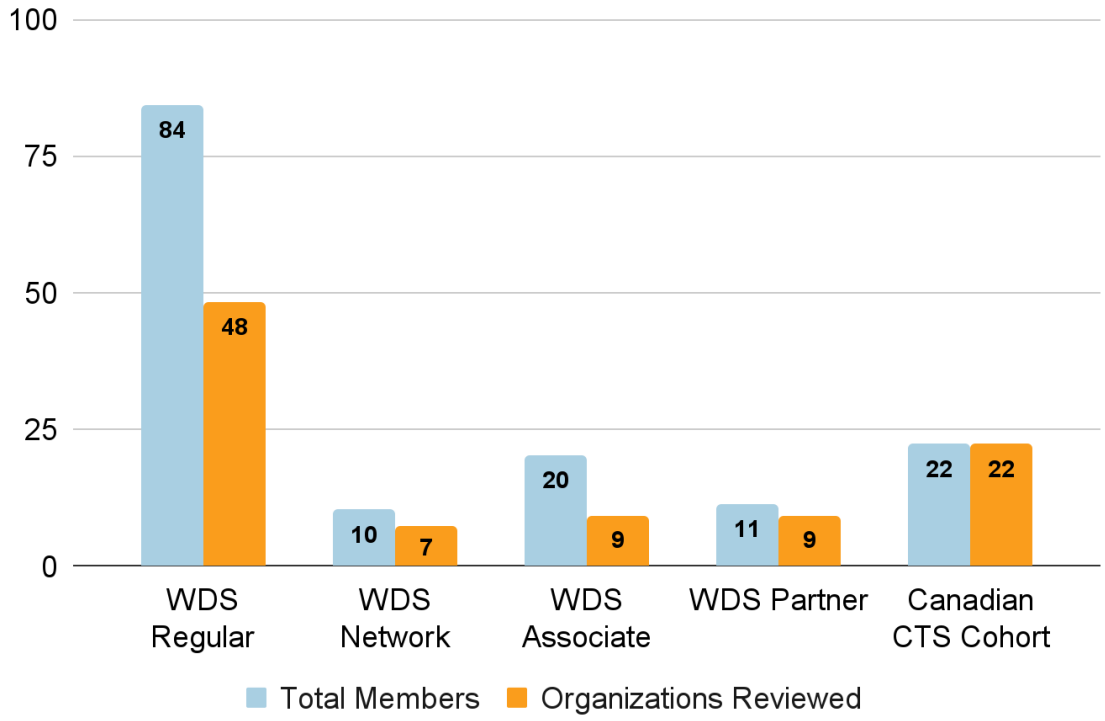

Figure 2. Comparison of the total number of target organizations we attempted to review, and the number of organizations actually reviewed. All of the organizations that were included in the review had one document reviewed per organization.

Of the 125 WDS members, 73 documents were reviewed, with one document reviewed per organization for a total of 73 organizations. Of the 22 Canadian CTS Cohort members, 22 documents or sources of information were reviewed, with one per organization for a total of 22 organizations. In total, between the WDS and Canadian CTS Cohort members, 95 documents were reviewed, for a total of 95 organizations reviewed. The goal of this assessment was to review strategic plans or technical roadmaps; however, due to the lack of available strategic plans or technical roadmaps, the type of documents under review was expanded. In total, only 36 out of the 95 reviewed documents were a strategic plan or technical roadmap. Therefore, documents such as CoreTrustSeal applications, annual reports, data policies, and journal articles were included within the review as well and ultimately accounted for a more significant number of the documents reviewed. Unfortunately, we found it difficult to find any additional documentation for the Canadian CTS Cohort. The decision was made to include resources such as

re3data[6] repository information and the Canadian CTS Cohort member's website in instances where no other information could be identified. Figure 3 shows a breakdown of the document types included in this review for the WDS and Canadian CTS Cohort members.

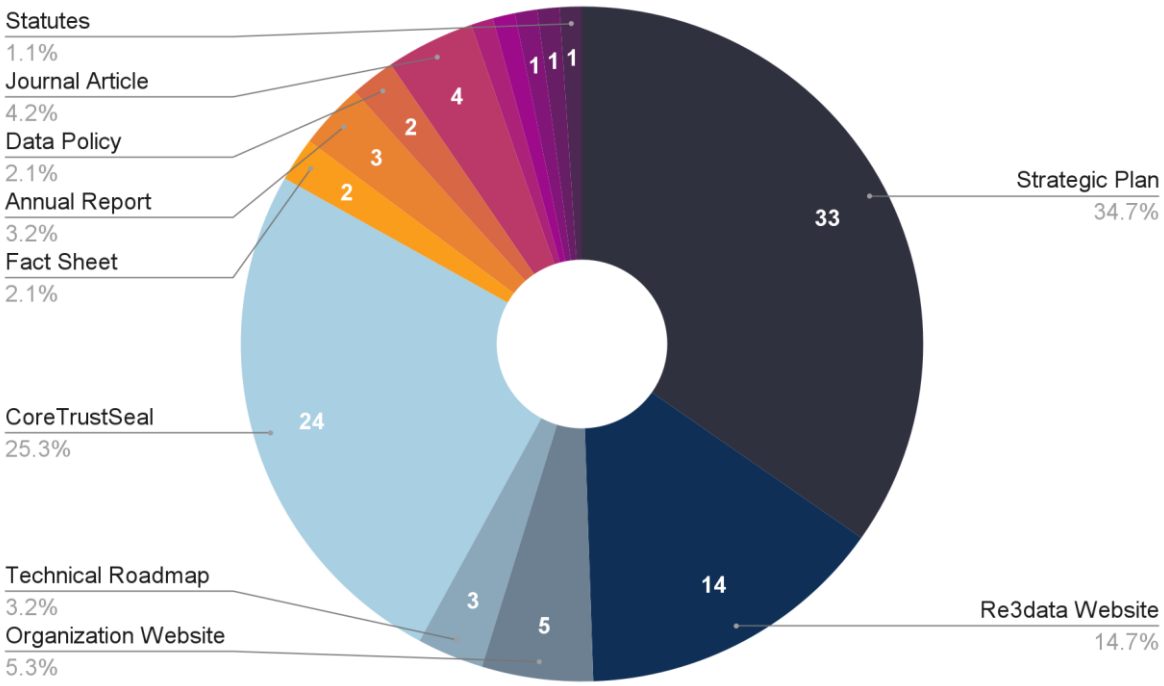

Figure 3. Document types included within the review for all repositories (both WDS and Canadian CTS Cohort members). [Document types not shown: Other Report: 1(1.1%), Technical Reference Manual: 1(1.1%), Newsletter: 1(1.1%), Magazine: 1(1.1%)]

Figure 4 shows the domains served by the WDS and Canadian CTS Cohort Members with documents included within this assessment (95 out of 147). However, it should be noted that many organizations are multi-disciplinary and fall into various domains. The most common domains for the WDS and Canadian CTS Cohort members that were included in this assessment are Biological Sciences and Earth and Environmental Sciences.

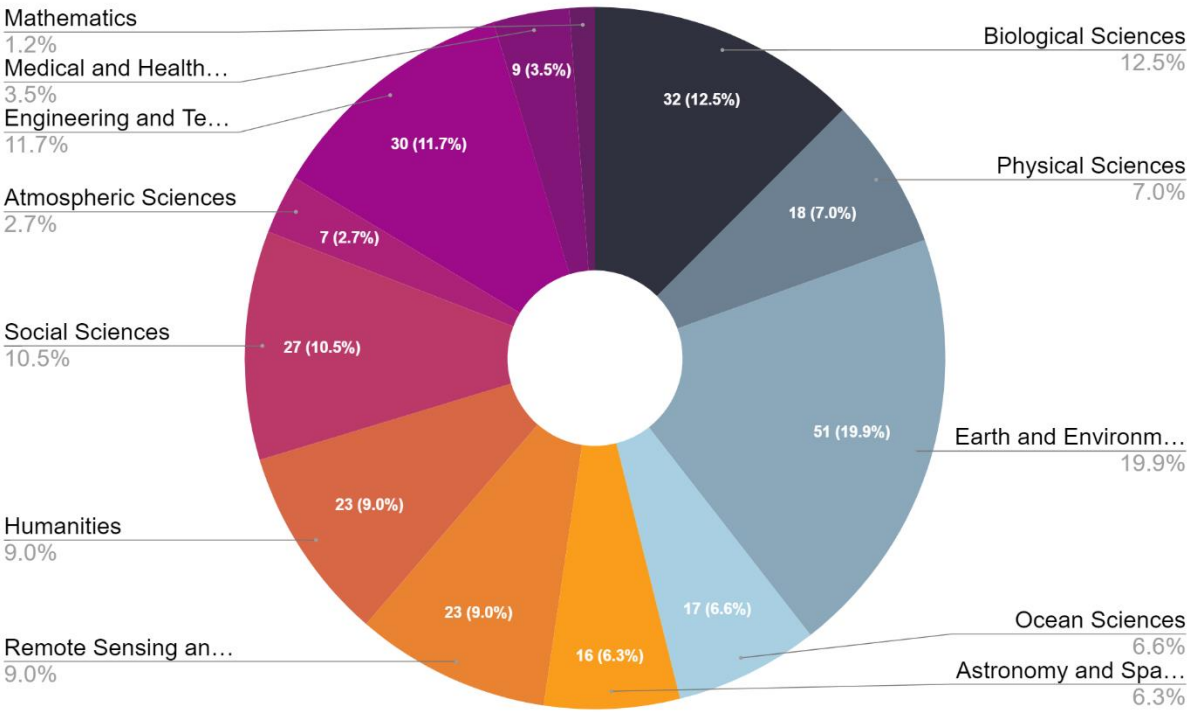

Figure 4. Domains of the WDS and Canadian CTS Cohort reviewed. [Values not shown: Ocean Sciences: 17 (6.6%), Astronomy and Space Sciences: 16 (6.3%), Atmospheric Sciences: 7 (2.7%), Medical and Health Sciences: 9 (3.5%), Mathematics: 3 (1.2%)]

We also summarized the organizational references to polar activities, references to indigenous groups, and references to advancing diversity and inclusion within their organization. 15/95 or 15.8% of organizations reviewed indicated that they had references to polar activities. The polar activities mentioned included the collection of research data from both the Arctic and the Antarctic, with datasets on cryosphere processes, sea ice, terrestrial snow and ice, glaciers, and climate change effects, among others. References to Indigenous groups were found in 10/95 organizations and included activities such as partnering and collaborating with Indigenous groups, safeguarding Indigenous data, supporting decolonization, land acknowledgements, and supporting the CARE principles for Indigenous Data Governance (Collective Benefit, Authority to Control, Responsibility and Ethics) and the First Nations Principles of OCAP[xiv] (Ownership, Control, Access and Possession) (Carroll et al., 2020; FNIGC, 2022). 18/95 organizations referenced advancing diversity, inclusion and equity, including some specific references to fostering a diverse and inclusive work environment and increasing participation amongst underrepresented and minority communities by providing education and reducing barriers.

3.1 WDS Regular Members

As previously stated, we have chosen to discuss each membership type individually with the belief that common themes amongst goals, challenges and needs would be more apparent within each membership class. The criteria presented for each membership type in Tables 1 - 5 show the criteria that were found to be the most relevant when identifying goals, priorities, needs and challenges for the organizations reviewed. As of December 2022, the WDS had a total of 84 Regular members. We reviewed 48 documents describing 48 of the WDS Regular members.

Table 1. Highlighted Criteria for WDS Regular Members

WDS Regular				
Do the Documents Reviewed Mention:	**Yes**	**No**	**Maybe**	**Total**
Mission Statement	36	11	1	48
Vision Statement	11	36	1	48
Guiding Principles	10	32	6	48
Long-Term Goals	17	23	8	48
Strategic Priorities	11	32	5	48
Planning/Outreach for Obtaining New Partnerships	14	30	4	48
Obstacles/ Challenges	18	30	0	48
Technical Requirements	19	29	0	48
Note: For the criteria above, the category of 'maybe' indicates organizations that may have reference to the specific criterion, but it was difficult to determine the relevancy of information.				

	Yes	**No**	**Maybe**	**N/A**	**Total**
Having Long-term and Sustainable Funding	25	0	8	15	48
Note: For the above criterion, 'N/A' indicates organizations that did not mention funding in the document reviewed, whereas 'maybe' indicates organizations that referenced funding, but the longevity or sustainability of the funding source could not be confirmed.					

Table 1 displays the criteria that were used to evaluate common themes, goals, challenges and needs and the number of references that were found in the documents reviewed for WDS Regular members. The most common theme that arose when looking at their mission statements, vision statements, and guiding principles was the desire to advance research, provide high-quality data products, increase collaboration amongst partnerships and within the user community, and ensure the long-term preservation of data. The last goal focuses on acting as a data steward and data custodian and promoting the exchange of data by ensuring data is open and easily accessible. Additional commonalities are the desire to protect the environment and address global change and challenges. Many of their guiding principles highlighted the need to be innovative, accountable, connected, respectful, and part of a community. Unsurprisingly, when assessing their goals and strategic priorities, many of them mirrored the driving factors defined in their mission and vision statements. However, more specific goals and priorities emerged, such as the desire to develop techniques for data collection, research to advance technology, fill data gaps, and provide actionable research that improves understanding and education.

Organizations also spoke repeatedly about their desire to be involved in international communication with like-minded organizations strengthening their external relationships and building long-term partnerships.

Currently, the largest obstacles for WDS Regular members fall into two categories, underfunding or lack of funding and struggles with infrastructure. Many organizations referenced a lack of funding for all their desired activities and projects, insufficient funding for continuous upward growth, lack of funding for staff, and lack of funding to improve infrastructure. Another common theme was the desire to move to a cloud-based infrastructure; however, migrating to newer technologies was slow. Funding presented itself as the leading challenge amongst WDS Regular members.

3.2 WDS Network Members

As of December 2022, the WDS had a total of 10 Network members. We reviewed 7 documents describing 7 of the WDS Network members. Approximately half of the WDS Network members with documents that had been included within this review had a mission, vision, or guiding principles for their organization. The most common themes expressed by the network members reviewed showed a desire to create infrastructure that provides high-quality data, products and services, such as observatory networks and online environments that would support researchers using their data. Of the four organizations that have either goals or strategic priorities, or both, the majority fall under the domains of remote sensing and astronomy and space sciences; therefore, the common goals represented are under the themes of improving networks of observatories, telescopes or other observation platforms. Other common goals expressed are the desire to strengthen further contacts that make use of the products they provide, facilitate data exchange, and expand their membership base and integration with other scientific communities. Community outreach was another priority that was highlighted, especially user feedback about ways they can improve products and develop new products that better serve their users.

Table 2. Highlighted Criteria for WDS Network Members

WDS Network				
Do the Documents Reviewed Mention:	**Yes**	**No**	**Maybe**	**Total**
Mission Statement	4	3	0	7
Vision Statement	3	4	0	7
Guiding Principles	2	5	0	7
Long-Term Goals	1	4	2	7
Strategic Priorities	4	3	0	7
Planning/Outreach for Obtaining New Partnerships	4	2	1	7
Obstacles/ Challenges	5	2	0	7
Technical Requirements	6	1	0	7
Note: For the criteria above, the category of 'maybe' indicates organizations that may have reference to the specific criterion, but it was difficult to determine the relevancy of information.				
	Yes	**No**	**Maybe**	**N/A**	**Total**
Having Long-term and Sustainable Funding	0	0	3	4	7

Note: For the above criterion, 'N/A' indicates organizations that did not mention funding in the document reviewed, whereas 'maybe' indicates organizations that referenced funding, but the longevity or sustainability of the funding source could not be confirmed

Challenges and technical requirements identified by the WDS Network members reviewed mainly revolved around their ability to meet the technical needs of their organization. Mentioned challenges were made between meeting the data accuracy, resolution, and timeliness requirements of what users' desire from their data products and what is actually feasible from the organization with current economic and organizational circumstances. Additionally, when looking at the distribution of organizations that have stated they have long-term funding and are sustainable in Table 2, three organizations had brief mentions of funding, but it was difficult to discern the terms of funding or what the references to sustainability implied, for instance, sustainability for the organization or sustainability for the products they provide. Therefore, based on the information collected from the WDS Network members, technical needs appear to be their most significant challenge moving forward.

3.3 WDS Associate Members

As of December 2022, the WDS had a total of 20 Associate Members. We identified and reviewed 9 documents describing 9 of these members. The majority of WDS Associate members with documents that were included in the review had either a mission or vision statement for their organization. The most common desires for these organizations were to be a supporting body for researchers and academic institutions, promote open data and the formation of openly shared data ecosystems, form international communities devoted to advancing scientific knowledge and research, embrace diversity and inclusivity, and support the next generation of researchers. Similar to the WDS Regular and Network members described above, the goals and strategic priorities of the WDS Associate members echo the desires expressed in the mission and vision statements and guiding principles. More specifically, the common goals are to ensure financial sustainability, create products and services that have a substantial impact on the end user, attract funders and partnerships, and improve outreach and facilitate engagement.

Table 3. Highlighted Criteria for WDS Associate Members

WDS Associate				
Do the Documents Reviewed Mention:	**Yes**	**No**	**Maybe**	**Total**
Mission Statement	7	2	0	9
Vision Statement	4	5	0	9
Guiding Principles	4	5	0	9
Long-Term Goals	6	2	1	9
Strategic Priorities	6	3	0	9
Planning/Outreach for Obtaining New Partnerships	6	1	2	9
Obstacles/ Challenges	6	3	0	9
Technical Requirements	2	7	0	9

Note: For the criteria above, the category of 'maybe' indicates organizations that may have reference to the specific criterion, but it was difficult to determine the relevancy of information.

	Yes	No	Maybe	N/A	Total
Having Long-term and Sustainable Funding	2	0	2	5	9
Note: For the above criterion, 'N/A' indicates organizations that did not mention funding in the document reviewed, whereas 'maybe' indicates organizations that referenced funding, but the longevity or sustainability of the funding source could not be confirmed					

The largest identified challenge faced by WDS Associate members is funding, both lack of overall funding and the need for consistent funding. These included themes such as not obtaining funding and not being able to cover the operating costs of their organization. Also noted was the issue of project-based funding. It was stated that only securing funding for specific projects diminishes the ability of the organization to perform other core tasks relating to its operation. Only 2 out of the 9 organizations with documents that were included within this review identified themselves as having a long-term funding source; the two "maybe" organizations in Table 3 reflect references in the reviewed documents that indicated that while they have project-based funding, they would require more resources to ensure that they can support all of their core operations.

3.4 WDS Partner Members

As of December 2022, the WDS had a total of 11 Partner Members. We identified and reviewed 9 documents describing 9 of these members. Out of the 9 organizations included as part of this review, all 9 members reviewed had some form of mission, vision, or guiding principles for their organization. Many of the same themes as the other WDS membership types were common amongst the WDS Partner members. These included the desire to advance user engagement, support international cooperation among organizations within the same or similar domains, build stakeholder relationships, and support the needs of data users. Research objectives were also included in many of the WDS Partner mission and vision statements. These objectives included their desire to collect and validate scientific data and provide tools to disseminate data to progress research. Progressing research and enabling the international scientific community were seen as particularly important to advancing their ability to solve key societal challenges. The goals and strategic priorities of the WDS Partner members are similar to the other WDS membership types and echo their core mission and vision statements. One of the most common goals amongst WDS Partner members is strengthening and promoting the role and impact of the organization. Steps for achieving this goal include the creation of activities that promote engagement, such as annual events, meetings with partner organizations, and the publication of white papers and other informative reports, as well as other opportunities that facilitate the promotion of the products and services of the organization.

Table 4. Highlighted Criteria for WDS Partner Members

WDS Partner				
Do the Documents Reviewed Mention:	**Yes**	**No**	**Maybe**	**Total**
Mission Statement	7	1	1	9
Vision Statement	8	1	0	9

Guiding Principles	5	3	1	9
Long-Term Goals	6	3	0	9
Strategic Priorities	7	2	0	9
Planning/Outreach for Obtaining New Partnerships	7	1	1	9
Obstacles/ Challenges	7	2	0	9
Technical Requirements	6	3	0	9

Note: For the criteria above, the category of 'maybe' indicates organizations that may have reference to the specific criterion, but it was difficult to determine the relevancy of information.

	Yes	**No**	**Maybe**	**N/A**	**Total**
Having Long-term and Sustainable Funding	0	2	2	5	9

Note: For the above criterion, 'N/A' indicates organizations that did not mention funding in the document reviewed, whereas 'maybe' indicates organizations that referenced funding, but the longevity or sustainability of the funding source could not be confirmed

Of the 9 WDS Partner members that were included in this assessment, 7 of them identified obstacles or challenges faced by their organization or technical requirements needed by their organization. The most common challenges faced were related to funding, open sharing, and data access. Lack of funding is one of the largest challenges faced by not only WDS Partner members but also among the entire WDS membership. The most common challenge described by WDS Partner members relating to funding was the need for long-term funding to ensure sustainability. Members described that short-term funding did not allow any long-term planning to be accomplished by the organization, and they had concerns about the lack of support. As seen in Table 4, 4/9 organizations referenced funding, with 2/4 stating that they did not have long-term funding. The other two organizations made reference to funding, but information was not provided about the length of time the funding was guaranteed. Data access was another concern; one WDS Partner member described that they rely on pay-walled data sources, while others had concerns about the lack of services and practices relating to data sharing and reuse.

3.5 Canadian CoreTrustSeal Cohort Members

A total of 22 repositories participated as part of the Canadian CoreTrustSeal Cohort. We reviewed 22 documents or websites describing all 22 of these cohort members. Unlike the WDS members reviewed above, the review of the CTS cohort included websites due to a lack of alternative information. Of the 22 Canadian CTS Cohort members, 12 organizations have a mission statement, vision statement or guiding principles or a combination of the three for their organization. Similarly to the WDS members, the most common themes expressed by the Canadian CTS Cohort members is the desire to be a global leader supporting research, promoting knowledge and data sharing with regards to the FAIR (Findable, Accessible, Interoperable, Reusable) principles, and to build and maintain strong partnerships. Preserving, curating, and disseminating data was also a common theme expressed in the documentation of the Canadian CTS Cohort members. Guiding principles included common subjects such as accessibility, sustainability, integrity, leadership, interoperability, and sharing. Of the organizations that listed their goals or strategic priorities, the most common themes were increasing the reach and role of the organization through advancing partnerships and increasing engagement with stakeholders and partners

that share specific goals, such as advancing scientific research in specific domains. Expanding data holdings was another goal mentioned by the Canadian CTS Cohort, as well as ensuring collections are high-quality, reliable, easy to access, and meet the needs of the user community, as well as the goal of improving infrastructure to meet other technological goals.

Table 5. Highlighted Criteria for Canadian CTS Cohort Members

Canadian CTS Cohort				
Do the Documents Reviewed Mention:	**Yes**	**No**	**Maybe**	**Total**
Mission Statement	11	6	5	22
Vision Statement	4	18	0	22
Guiding Principles	8	14	0	22
Long-Term Goals	4	18	0	22
Strategic Priorities	4	17	1	22
Planning/Outreach for Obtaining New Partnerships	3	17	2	22
Obstacles/ Challenges	1	21	0	22
Technical Requirements	0	22	0	22
Note: For the criteria above, the category of 'maybe' indicates organizations that may have reference to the specific criterion, but it was difficult to determine the relevancy of information.				
	Yes	**No**	**Maybe**	**N/A**	**Total**
Having Long-term and Sustainable Funding	3	0	2	18	22
Note: For the above criterion, 'N/A' indicates organizations that did not mention funding in the document reviewed, whereas 'maybe' indicates organizations that referenced funding, but the longevity or sustainability of the funding source could not be confirmed.					

We were able to identify challenges faced by one organization in the Canadian CTS Cohort. Specifically, the challenge that technological change had brought increased cyber-security risks. This may be a challenge experienced by more than one of the cohort; however, we cannot draw any more conclusions with our current data. Table 5 shows which Canadian CTS Members have sustainable and long-term funding based on our assessment. Four organizations identified that they had a funding source, and one organization possibly had a funding source, but it needed to be clarified about the longevity of that source. 18 members did not have any reference to sustainability or long-term funding in the information sources that were included in this assessment. Therefore, we are unable to draw any conclusions on whether funding is a challenge for the Canadian CTS Cohort.

4. Discussion

In broad strokes, we identified the need for sustainable funding and a desire to create effective partnerships as priorities for all organizations reviewed. In addition, all organizations have technical challenges, and the scope of those needs will need to be clarified with in-depth interviews with organization representatives. The Canadian Cohort goals and priorities matched similarly with the rest of the WDS members. However, it was difficult to identify challenges for the Canadian cohort. Only one organization stated they had a challenge, and it was related to concerns about cyber-security.

Ultimately, our research was limited by our use of publicly available strategic plans for the 147 World Data System and Canadian CoreTrustSeal Cohort. Of the 95 documents that were included in this assessment, only 36 of them were a strategic plan or technical roadmap. Ultimately, our assessment included a much larger percentage of other types of documents, as seen in Figure 3. Therefore, because many of these documents were not designed to include criteria such as goals, priorities, or mission statements like strategic plans, we were largely unable to identify challenges or needs for a larger amount of our target audience than originally intended. Therefore, the results of this research can only be used to summarize the common themes expressed by those organizations who referenced them and not the whole of the WDS or Canadian CTS Cohort membership. Finally, our recommendations, therefore, are based on this subset of organizations.

Based on our findings, our recommendations for future research are that a targeted call for strategic plans/action plans or technical roadmaps is sent to each organization. Additionally, we would recommend that an assessment survey instrument be developed based on the review instrument we created. This instrument would be sent to the data manager for each Canadian CTS Cohort member and WDS member. Each WDS member organization completes a report to the WDS Scientific Committee, and this survey could be incorporated as part of this report per WDS membership guidelines. The survey would create a 1:1 assessment for all of our identified criteria in this research assessment and remove the ambiguity of the maybe responses outlined above. The information included in the needs assessment survey would be GBC criteria; challenges; goals; diversity initiatives; and adherence to FAIR, TRUST, and CARE, among other criteria. We also recommend that this needs assessment be sent to each new WDS member organization as an onboarding measure.

For the Canadian CTS Cohort members, we suggest that they take part in brief interviews with our researchers. Only 3 of the 22 cohort members have a strategic plan, and this group may be in the process of creating planning documentation as they compile their CTS application materials. It should be noted that a strategic plan is not a requirement for CoreTrustSeal Certification, but in preparing a strategic plan, the cohort members will be creating an outline of information that will be needed for the CTS certification criteria. For example, the CTS requirements for certification include the organization's mission, vision, sustainability plan, and data provenance guidance, all items that may also be included in a strategic plan. The interviews will allow us to assess where the cohort members are in terms of documentation for their repository. Finally, we can expand the documentation being assessed to include other certifications for data repositories. The focus for this analysis was CoreTrustSeal, but documentation from applications for certification to NISO, Department of Energy, or other certifying organizations may allow us to more readily gather data aligned with GBC identifiers and other factors for assessment of goals and challenges. Again, we suggest a targeted call to all of the organizations to request certification documentation from other certifying bodies for data repositories.

5. Conclusion

This needs assessment provided insight into the needs of the target repositories without an additional time commitment of those organizations. The assessment method built on the work they have already done and in that respect, it is a valuable activity for the WDS. However, this process does lack some detail and further engagement with these organizations will be necessary. The method we developed could be part of the preparatory work for any consortia that is engaging in strategic planning.

Based on the analysis from this report, World Data System will recommend moving forward in assisting Canadian repositories and WDS members in several ways. These recommendations are based on the World Data System Action Plan 2022 through 2024[xv] (WDS, 2022). The current World Data System Action Plan Goals are:

1. Provide services and support to existing and new members
2. Develop value narratives for WDS members
3. Provide global leadership and agenda setting
4. Enhance access, quality and accessibility of data worldwide

In light of these goals, and as a result of this work we can recommend to following actions be taken by the WDS:

1. Through this analysis, we have identified key challenges for data repositories around transparency, reproducibility, user-focus, sustainability, and technology (TRUST). In line with our action plan goals, WDS could help repositories create a strategic plan/action plan or technical roadmap that clearly outlines how they are achieving their goals and addressing their challenges. These plans or roadmaps will follow the guidelines as outlined in the TRUST principles[xvi] (Lin et al., 2020). A clear strategic plan including TRUST principles will aid in implicitly stating each member's value proposition.
2. WDS should launch a webinar/workshop series on overcoming common challenges as identified through our research. These challenges include identifying and applying for sustainable funding, creating partnerships, open sharing, data access, technical needs, building/maintaining infrastructure, and handling the increase in data volume and format.
3. WDS could create a resource area as part of the World Data System website to include ways that repositories may more effectively communicate how they are implementing TRUST, FAIR and other data standards. This could include information on how each repository may communicate how they are meeting Global Biodata Coalition (GBC) Criteria or other discipline-specific data criteria or principles (Global Biodata Coalition, 2022).
4. WDS should provide communication through newsletters to the Cohort and members regarding funding opportunities to enable data repositories to create sustainability plans and should also promote and engage in new funding models in development, including UNESCO open science funding models.
5. WDS is developing a customer relationship management system for its members. This system should enable WDS members to communicate effectively in a membership forum to allow

members to connect to data experts among the membership, permitting our members to collectively find answers to common challenges.

6. WDS could partner with CODATA and RDA to provide working groups and educational opportunities for its members. They are already collaborating on SciDataCon and International Data Week, the largest gathering of data experts. At these events, WDS and its partners will provide information on best practices related to finding sustainable funding, creating partnerships, open sharing, data access, technical needs, building/maintaining infrastructure, and handling the increase in data volume and format.
7. The WDS has generated a list of the organizations that supported Polar research identified in this review and, going forward, should include them in outreach activities about relevant ongoing polar data support programs headed by the WDS International Technology Office (ITO).
8. WDS should investigate opportunities to support member technical challenges identified in this review or in other scoping and needs assessment activities, for example supporting migrations to cloud infrastructure and advancing cyber-security.

It is the recommendation of the research team that WDS should commit to an ongoing needs assessment for member data repositories to be compiled on an annual basis. Finally, WDS will need to implement evaluation and monitoring tools to gauge the efficacy of its efforts in education and resource building to overcome data repository challenges.

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[vi] https://worlddatasystem.org/about/constitution/

[vii] Global Biodata Coalition (GBC). https://globalbiodata.org/

[viii] Global Core Biodata Resources: Concept and Selection Process https://zenodo.org/record/5845116#.ZBI1CnbMJD8

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[x] Re3data Registry of Research Data Repositories. https://www.re3data.org/

[xi] CoreTrustSeal Certified Repositories. https://amt.coretrustseal.org/certificates

[xii] Resoomer. https://resoomer.com/en/

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