Canadian Wildlife Federation

Canadian Aquatic Barriers Database

Project Background and Overview

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CANADIAN WILDLIFE FEDERATION

The Canadian Wildlife Federation (CWF) is a national not-for-profit charitable organization dedicated to ensuring an appreciation of our natural world and a lasting legacy of healthy wildlife and habitat. By spreading knowledge of human impacts on the environment, developing and delivering educational programs, conducting research, promoting the sustainable use of natural resources, and advocating for effective wildlife policy and regulation, CWF strives for a future in which Canada's wildlife is conserved for generations to come. Since its incorporation in 1962, CWF has worked to conserve Canada's wildlife and their habitats for future generations, and to educate young Canadians on the importance of protecting wildlife. At CWF, we believe Canadians can encourage change and foster a global understanding through responsible, collaborative action.

In recent years, CWF has expanded its freshwater connectivity and fish passage programs at local, provincial, and national scales, including:

- → Chinook salmon research and fish ladder effectiveness monitoring in the Upper Yukon River
- → American eel research and advocacy surrounding hydropower facility mitigation plans to reduce turbine mortality and increase support for protecting and recovering the species
- → Developing and implementing the Watershed Connectivity Remediation Planning framework in British Columbia and Alberta to restore watershed connectivity and undertake barrier remediation projects
- → Development of the Canadian Aquatic Barriers Database

CANADIAN AQUATIC BARRIERS DATABASE

All Canada's aquatic barrier and connectivity information in one place – easily and openly accessible!

Freshwater aquatic connectivity is an increasingly important, but underdeveloped area of focus in the study of ecosystem processes and conservation efforts at a national scale in Canada. Barriers to aquatic connectivity can include manmade infrastructure such as dams, weirs, and stream crossings (e.g., culverts), as well as natural features such as waterfalls. These include both barriers in the longitudinal plane (i.e., upstream-downstream), as well as lateral barriers disconnecting rivers and lakes from their riparian wetlands and floodplains. These barriers within freshwater systems limit the movements of aquatic species, many of which rely on annual migrations within or between freshwater and marine ecosystems to complete their life cycles, and disrupt ecological process including nutrient cycling, sediment flows, and temperature regulation.

The remediation of aquatic barriers, either through their removal or through installation of fishways, is a growing field in restoration ecology and efforts to strategically map and prioritize barriers for remediation have become increasingly popular. Small barriers have been mapped in certain watersheds and regions in Canada to support these efforts; however, no database currently integrates small and large barriers at a national scale along with standardized attributes that inform decision making. A national database of aquatic barriers would provide a key cornerstone for aquatic connectivity research, barrier prioritization analyses, and fish passage remediation.

In an effort to fill this void, CWF, with support from partners and engaged stakeholders, is leading the development and compilation of the Canadian Aquatic Barriers Database (CABD) – a standardized

national database of barriers to aquatic connectivity, both anthropogenic and natural. The CABD comprises three main components: a clean and connected national hydrographic (stream and river) network, standardized datasets for multiple barrier types (see Table 1), and a publicly accessible web mapping tool. This interface will enable users to explore, filter, and download hydrographic and barrier information. The database will support network analyses over large geographic scales to prioritize barriers that present the greatest potential ecological benefits if remediated.

A "sneak peek" of Version 1 of the CABD (CABDv1) was launched in November 2021, and as of April 2022 dam, waterfall, and fishway data have been release for Alberta, British Columbia, New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island. Data for the remaining provinces and territories is scheduled to be released on a monthly basis until national coverage is complete in summer 2022. Once completed, the CABDv1 will contain 30,000+ dams, 10,000+ waterfalls, and 400+ fishways.

The goal of the CABD is provide a curated, central, and open source for barrier and connectivity data in Canada, by compiling existing and acquirable datasets, filling data gaps across the country, and sharing data updates back to providers, where possible. Standardized data structures will be developed for each barrier type to facilitate database management and population, including collecting and validating field assessment data for identified barriers. Over time, additional datasets including habitat assessment data, historical and current species distribution data, and links to other open data sources will be integrated into the database.

The Canadian Aquatic Barrier Database will be the central pillar of a suite of tools to support habitat status assessments and reporting, informing management and regulatory decisions, restoration planning and prioritization, infrastructure asset management, research and monitoring programs, and education and public outreach initiatives. Additional tools include the development of standardized barrier assessment and habitat confirmation protocols for use across Canada, a citizen science mobile application to facilitate barrier identification and rapid assessment, and web-based tools to perform hydrographic network analysis and prioritize barriers. The Canadian Aquatic Barriers Database is a multi-year project that is supported partially by financial contributions from Fisheries and Oceans Canada and the RBC Foundation.

Table 1. CABD Feature Types.

Version 1
Dams (large, medium, and small) – includes some weirs and dykes
Waterfalls
Fishways
Future Versions
Stream crossings (road, rail, and trail; expected 2023)
Lateral barriers (dykes, levees, and other structures; expected 2023+)

STAKEHOLDER ENGAGEMENT FRAMEWORK

CWF is interested in developing this database to support barrier remediation prioritization analyses; however, the utility of a national-scale database of this nature extends beyond fish passage applications. The creation of a national database and framework to support freshwater connectivity efforts necessitates multilateral collaboration across geographic regions, legislative jurisdictions, and private and public sectors. No such forum existed to facilitate discussions specific to freshwater aquatic connectivity and barrier remediation at a national scale. As such, to support and facilitate the development of the Canadian Aquatic Barriers Database, CWF has established a national stakeholder engagement framework to discuss barriers to aquatic connectivity and fish passage, and to actively engage with interested parties, potential end-users, and data providers, to elicit feedback for the development of the CABD.

The Stakeholder Engagement Framework comprises four components:

1. *User requirements interviews* – A standardized questionnaire used during phone interviews to elicit feedback on database value and types of use, scale of work, and data requirements and access. The user requirement interviews were completed during the fiscal year 2019-20.
2. *CABD Working Group* – The Working Group aided in the synthesis of the results of the stakeholder interviews. The group is responsible for providing feedback and input on (among other topics) target end uses and data requirements, decisions related to project objectives and outcomes, and existing aquatic barrier datasets. The group remains active with monthly conference calls.
3. *CABD Technical Advisory Committee* – The Technical Advisory Committee assists in final decision-making review of products from the Working Group. The committee is responsible for providing feedback and input on technical aspects of project implementation, including but not limited to, database design, logistic consideration for data compilation and mechanisms to fill data gaps, and long-term strategic planning. The committee remains active with monthly conference calls.
4. *Reciprocal data-sharing relationships* – The data-sharing relationships are established between CWF and existing data creators, compilers, and managers. The relationships are reciprocal to ensure mutual benefit, facilitate collaboration, prevent the duplication of efforts, and maintain long-term data currency.

Stakeholders include representatives from all levels of government, NGOs, local and community groups, researchers, and industry. The stakeholder engagement process has successfully provided advice on feasibility, identification of target end uses and associated data requirements, data acquisition and compilation, database design, and mechanisms to fill data gaps. This stakeholder network supports Canada-wide collaboration on aquatic connectivity, allows for efficient dissemination of information, and ensures that the CABD is a functional tool that can support a range of projects across multiple sectors (see Appendix A for a summary of identified use cases).

FUTURE STEPS

To date, CWF has established an engaged stakeholder network that raises ground-level awareness, support, and input for the CABD. CWF is building on work initiated by Natural Resources Canada to develop a cutting-edge and analysis-ready hydrographic network to ensure that the CABD is developed to support the integration of newly available analysis tools via application programming

interfaces (APIs). Additionally, the Working Group and Technical Advisory Committee have helped identify barrier types that are important and feasible to include in the database, and data modelling (i.e., selection of standardized attributes) has been completed for dams and waterfalls.

Project implementation will continue to occur through three key areas:

1. Strategic planning (with support of the Working Group and Technical Advisory Committee), including:
    - → Develop project governance structure to efficiently coordinate relationships from national to local scales, including with government agencies, NGOs, industry, researchers, and grassroots organizations
    - → Logistic considerations for compiling existing datasets and developing mechanisms to fill data gaps
    - → Identify options for long-term 'ownership' and funding for the CABD to ensure on-going updates and maintenance
2. Database development, including:
    - → Complete release of CABDv1 (June 2022)
    - → Continue to establish reciprocal data-sharing relationships
    - → Complete data modelling for stream crossings and additional barrier types
    - → Quality assurance/quality control and standardization of barrier datasets
    - → Investigate and implement mechanisms to fill data gaps
    - → Integrate additional tools and functionality to the web-mapping tool
3. Development of complimentary tools, including:
    - → Standardized barrier-assessment protocols for field data collection
    - → Remote sensing and geospatial modelling tools to identify barriers and estimate passability
    - → A citizen-science mobile application to allow partners to collect and enter data in CABD

APPENDIX A: SUMMARY OF CABD USE CASES

A key component of the stakeholder engagement process was the execution of 'user requirements interviews' with a broad cross-section of target end users from a variety of sectors and fields of work. A standardized questionnaire was used during phone interviews to elicit feedback on database value and types of use, scale of work, and data requirements and access. The primary goal of the interview process was to obtain feedback on potential end uses for the CABD, data requirements associated with each use, and means of accessing the data. The results of the individual user interviews were synthesized to identify common potential end uses and create broad 'Use Types' that encompass related 'Use Cases'. Table 2 summarizes the proposed 'Use Types' following preliminary synthesis of the stakeholder interview results, including the most commonly identified 'Use Cases'.

Table 2. Summary of CABD 'Use Types' and 'Use Cases'.

Use Type: Regulation, policy, and reporting		
Use Case	**Requirements**	**Data Access**
Variable-scale reporting on the state of fish, fish habitat, and watershed status, including the development of indicators to assess/quantify freshwater connectivity	→ Consistent geographic scales/coverage and standardized attributes for each barrier type → Identify, locate, and visualize barriers to aquatic connectivity in a defined area of interest → Assessments or estimates of passability for each barrier structure (focus is on fish, though other species may be considered) based on physical attributes and hydrologic conditions → Topological coincidence of barrier data and hydrographic network to support network analyses (e.g., upstream/downstream traces, calculation of contributing catchment areas, calculation of barrier densities, etc.) → Ability to calculate some basic connectivity indicators (to be determined) within the web mapping tool would be useful, but not a necessity	→ Visualize barrier data and hydrographic network, and access attribute information, via web mapping interface → Download data in either .csv or geopackage/shapefile format → High-quality metadata is required → Provision of data through an API would be useful, but not a necessity
Assessing regulation, compliance, and enforcement of existing hydropower facility	→ Detailed, consistent, and accurate attributes for dams and associated hydropower facilities (i.e., focus on data quality)	→ Visualize barrier data and hydrographic network, and

	→ Ability to link to key hydrologic data (e.g., reservoir size, rate of discharge, degree of regulation, etc.) → Ability to crosswalk with existing databases (e.g., Fisheries and Oceans Canada's Fisheries Act Authorizations database) → Ability to input assessment data into CABD as it is collected to ensure data currency	access attribute information, via web mapping interface → Download data in either .csv or geopackage/shapefile format → Provision of data through an API would be useful, but not a necessity → Access to data entry portal for accredited partners

Use Type: Conservation/restoration planning and prioritization		
Use Case	**Requirements**	**Data Access**
Strategically prioritize barriers for remediation to improve fish passage	→ Support cost-benefit analyses to identify "high-value" barriers based on replacement cost, species distributions, and habitat quality/quantity to efficiently allocate resources and obtain "biggest bang for buck" → Identify, locate, and visualize barriers to aquatic connectivity in a defined area of interest → Assessments or estimates of passability for each barrier structure (focus is on fish, though other species may be considered) based on physical attributes and hydrologic conditions → Topological coincidence of barrier data and hydrographic network to support network analyses (e.g., upstream/downstream traces, calculation of amount/quality of habitat upstream of a barrier, calculation of contributing catchment areas, calculation of barrier densities, etc.) → Ability to score/rank or optimize "high-value" barriers based on different management objectives (to be determined) within the web mapping tool would be useful, but not a necessity	→ Visualize barrier data and hydrographic network, and access attribute information, via web mapping interface → Download data in either .csv or geopackage/shapefile format → High-quality metadata is required → Provision of data through an API would be useful, but not a necessity

Identify projects for habitat banking and mitigation/offsetting	→ Identify, locate, and visualize/symbolize barriers to aquatic connectivity based on remediation/restoration "value" in a defined area of interest → Ability to integrate barrier data and "value" with high-resolution habitat data to accurately estimate habitat banking and mitigation/offsetting value	→ Visualize barrier data and hydrographic network, and access attribute information, via web mapping interface → Download data in either .csv or geopackage/shapefile format → Provision of data through an API would be useful, but not a necessity

Use Type: Infrastructure asset management		
Use Case	**Requirements**	**Data Access**
Modernized, standardized, and central repository for inventory of barrier infrastructure (e.g., dams, culverts) locations and physical conditions	→ Identify, locate, and visualize barriers to aquatic connectivity in a defined area of interest → Detailed, consistent, and accurate attributes for each barrier type to facilitate modernization of data storage and management (i.e., move away from paper/Excel and towards technologically current DBMS) → Accurate and precise barrier locations → Ownership and liability attributes are required → Ability to track renovation and assessment cycles for barrier infrastructure to identify opportunities to take advantage of scheduled replacement/maintenance to improve passability of structures (i.e., need to keep attributes up to date) → Ability to input assessment data into CABD as it is collected to ensure data currency	→ Visualize barrier data and hydrographic network, and access attribute information, via web mapping interface → Download data in either .csv or geopackage/shapefile format → Provision of data through an API would be useful, but not a necessity → Access to data entry portal for accredited partners

Use Type: Research and monitoring		
Use Case	**Requirements**	**Data Access**
Develop functional and/or structural connectivity indicators	→ Identify, locate, and visualize barriers to aquatic connectivity in a defined area of interest	→ Visualize barrier data and hydrographic network, and

and explore links to biological/ecological processes	→ Consistent geographic scales/coverage and standardized attributes for each barrier type to allow for comparative analyses → Assessments or estimates of passability for each barrier structure (focus is on fish, though other species may be considered) based on physical attributes and hydrologic conditions → Topological coincidence of barrier data and hydrographic network to support network analyses (e.g., upstream/downstream traces, calculation of amount/quality of habitat upstream of a barrier, calculation of contributing catchment areas, calculation of barrier densities, etc.) → Ability to link to/integrate other ecological/biological datasets (e.g., species distributions, land use, water quality, etc.)	access attribute information, via web mapping interface → Download data in either .csv or geopackage/shapefile format → High-quality metadata is required → Provision of data through an API would be useful, but not a necessity
Effectiveness monitoring to evaluate management and mitigation measures following project implementation to improve connectivity	→ Identify, locate, and visualize barrier remediation/restoration projects that have been completed in a defined area of interest → Consistent geographic scales/coverage and standardized attributes for each barrier type to allow for comparative analyses → Ability to link to/integrate monitoring datasets associated with individual projects → Ability to edit/update data in CABD based on results of effectiveness monitoring (e.g., passability score)	→ Visualize barrier data and hydrographic network, and access attribute information, via web mapping interface → Download data in either .csv or geopackage/shapefile format → High-quality metadata is required → Provision of data through an API would be useful, but not a necessity → Access to data entry portal for accredited partners

Use Type: Education and outreach		
Use Case	**Requirements**	**Data Access**
Identify restoration projects and	→ Identify, locate, and visualize barrier remediation/restoration projects that have been completed in a defined area of interest	→ Visualize successful projects and hydrographic network,

communicate success stories	→ Ability to link to project documentation (e.g., website, reports, etc.) → Ability to visualize the impact each project achieved to improve freshwater connectivity (e.g., highlight amount of stream kilometers or other habitat measures that are now accessible due to the project's implementation) → Ability to edit/update data in CABD based on project implementation (e.g., remove 'barrier', change passability score, etc.)	and access attribute information, via web mapping interface → Download data in either .csv or geopackage/shapefile format → Access to data entry portal for accredited partners
Create a central repository of resources to support the transfer of knowledge across the country	→ As a compliment to the database, a separate section of the web interface to house the compilation and curation of a 'Freshwater Connectivity Toolkit' with documents and links to resources (e.g., local/regional/provincial legislations, best management practices, etc.)	→ Access toolkit through web interface