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Cumulative Effects Spatial Data Tool (CICADA) User Manual

Version 1.0

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TOOL OVERVIEW

The **C**umulat**I**ve Effe**C**ts Sp**A**tial **D**ata (CICADA) Tool is a national tool intended to support decision-making at Fisheries and Oceans Canada by compiling information on fish, fish habitat, and stressors that can affect Canada's freshwater ecosystems. The tool synthesizes readily available, open data for inland regions i.e., information for marine and offshore regions of Canada's large lakes are not included. Queries using the tool will return site- and watershed-level data available for the watershed surrounding a focal site (e.g., a proposed development site), and these data are presented in spatial and tabular formats. CICADA is presently available for DFO users only, and can be found on the Ecosystems and Oceans Science DM Apps portal.

A general workflow for using CICADA is outlined below:

1. User selects a focal site within Canada. This site could be the location of a proposed work, undertaking or activity (WUA), designated project under the *Impact Assessment Act* (2019), or another site of interest.
2. User selects the scale of watershed that they wish to view the fish, fish habitat and stressor data.
3. CICADA identifies and maps the watershed in which the focal site is located (the 'focal watershed').
4. CICADA maps, and provides tabular data available for fish, habitat and stressors for the focal watershed.
5. Users can explore data on the interactive map, create screenshots as required, and download any relevant tabular data for further analysis.

1. GETTING STARTED

Users can find and launch the tool from Ecosystems and Oceans Science's DM Apps portal (http://dmapps/en/shiny-apps/). Accessing the portal will require the user to be on a DFO network or connected to the departments Virtual Private Network (VPN). DM Apps may ask for a DFO email for verification. Enter your DFO email address and DM Apps will grant access.

Upon launching the tool, users should see a landing page describing the CICADA tool and the data sources included. Users should then navigate to the 'Interactive map' tab to begin using the tool (Figure 1).

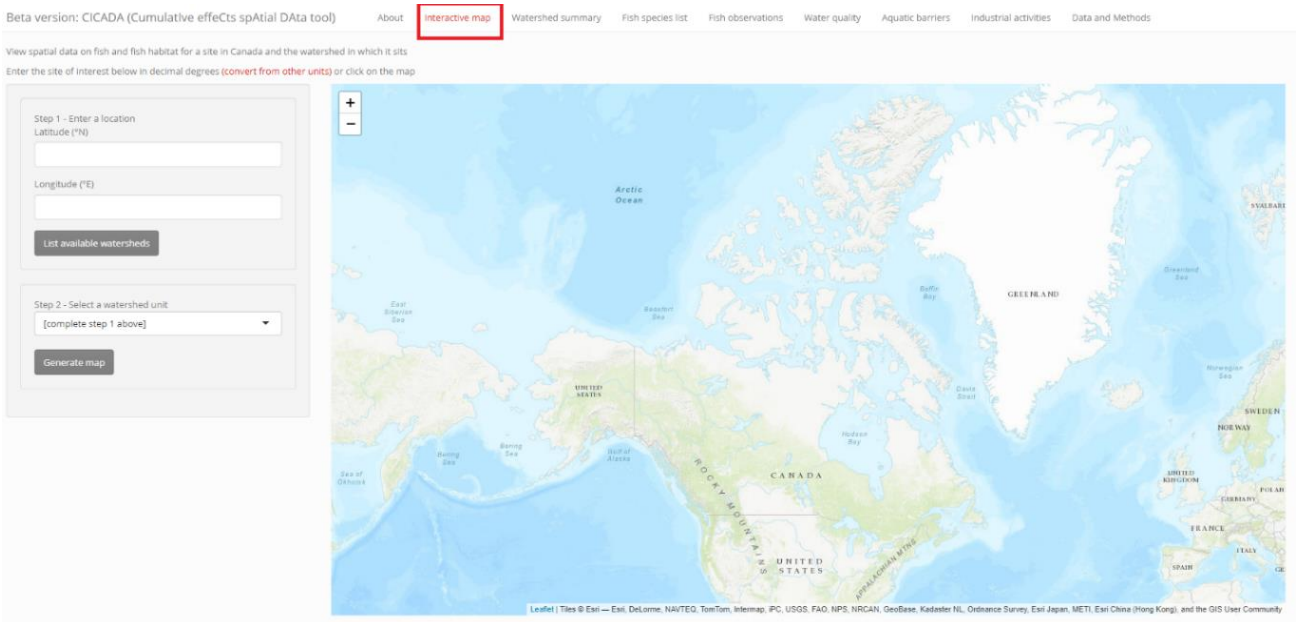

Figure 1. Interactive map tab of the CICADA tool.

SELECTING A SITE

The first step in using CICADA is to select a site within Canada. This site could be the location of a proposed work, undertaking or activity (WUA), designated project under the *Impact Assessment Act* (2019), or another site of interest. As CICADA focuses on supporting decision making in freshwater environments, site selection is restricted to terrestrial or inland aquatic systems. Furthermore, there is limited information available for offshore locations in the Laurentian Great Lakes and other large lakes e.g., Great Slave Lake.

A focal site can be selected either by clicking on the map, or by entering a focal latitude and longitude in the box marked 'Step 1' to the left of the map. If entering a latitude and longitude directly into the box, it must be in decimal degrees.

SELECTING A WATERSHED SCALE

Once a site is selected, the user should click on the 'List available watersheds' button to populate a list of the potential watershed scales that can be used for further mapping and table construction.

All inland sites should be covered by the National Hydrographic Network (also known as the National Hydro Network) tertiary watershed layer included in CICADA (Figure 2), and this layer will be listed as an option in the dropdown list. Additionally, CICADA can provide data at a smaller watershed scale (Figure 3) for sites within British Columbia (BC Freshwater Atlas units), Alberta (Hydrological Unit Code Level 8 units) and Ontario (Ontario Watershed Boundaries Quaternary Watershed units). These provincial watershed layers are consistent with the scale at which many spatial planning processes occur, and may therefore be preferred by the user when they are available.

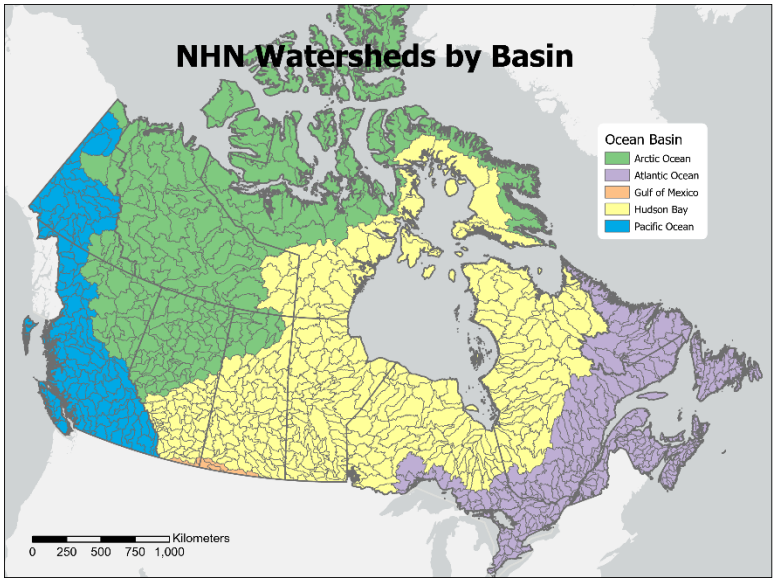

Figure 2. National hydrographic network (NHN) tertiary watersheds in Canada, which are included as an option for clipping data in CICADA. Basins are shown for interest and are not specifically represented in CICADA.

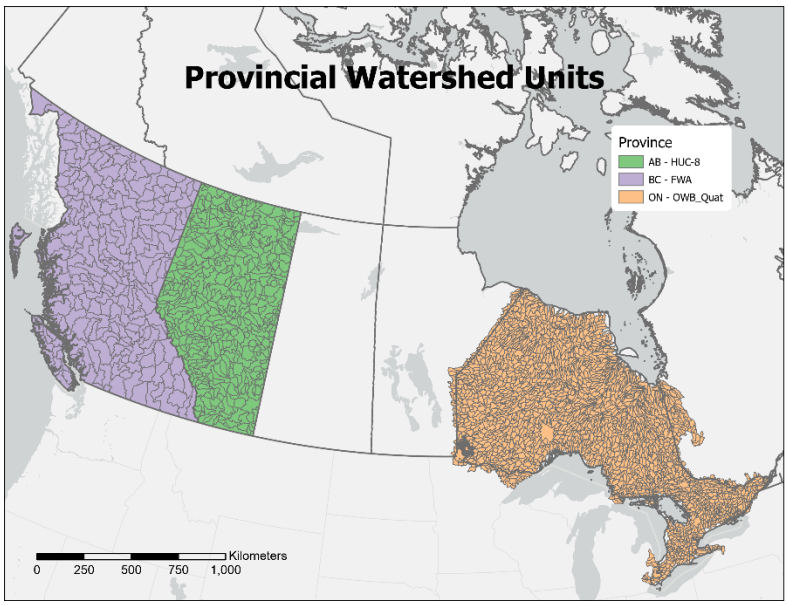

Figure 3. Provincial watershed layers available for data clipping in CICADA including British Columbia Freshwater Atlas (BC-FWA), Alberta Hydrological Unit Code Level 8 (AB- HUC-8), and Ontario Watershed Boundary Quaternary Watersheds (ON – OWB_Quat).

GENERATE MAP AND TABULAR DATA

Once the user selects a watershed scale (unit), they can click on 'Generate Map' on the left side of the Interactive map tab. Clicking this button will: 1) identify and map the boundaries of the focal watershed by identifying which specific watershed (within the selected watershed scale) contains the focal site, and 2) generate map layers and tables of all the fish, fish habitat and stressor data available for the focal watershed.

2. MAPPED AND TABULAR DATASETS

The selection of datasets for inclusion in CICADA was based on recent science advice that outlined the information needs for assessing cumulative effects (Hodgson et al. 2022), on the availability of data, and on the spatial coverage of data sets (datasets with national or broad regional coverage were prioritized over those with smaller spatial extents). CICADA compiles and provides 3 main types of data in support of decision making (Figure 4).

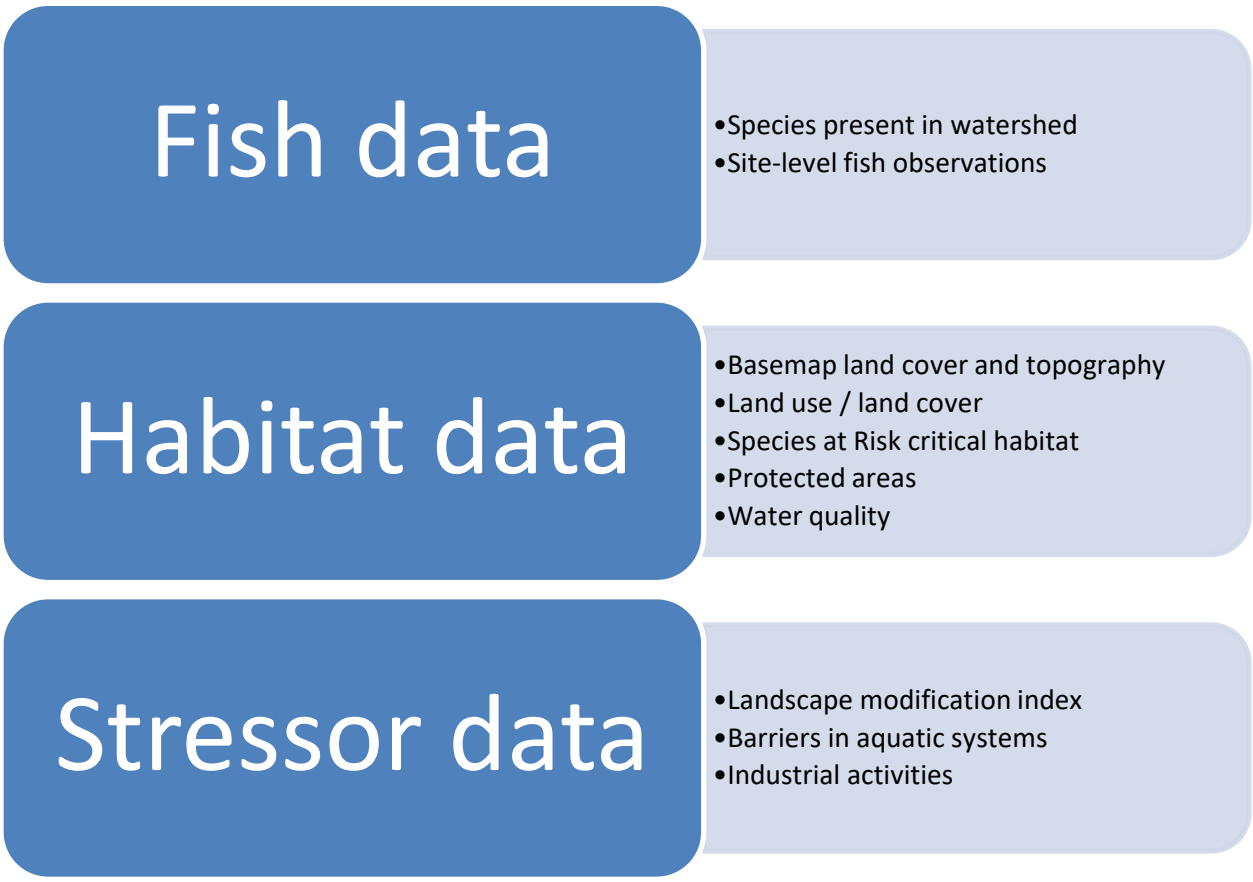

Figure 4. Conceptual schematic of the three types of data provided in CICADA.

Watershed Summary

The Watershed Summary is accessible via the Watershed Summary Tab (Figure 5) and presents high level information about the focal watershed and focal site. This information includes:

- the freshwater ecoregion in which the focal watershed sits (Freshwater Ecoregions of the World),
- the COSEWIC freshwater biogeographic zone in which the focal watershed sits, based on COSEWIC guidance for delineating designatable units (COSEWIC 2020)
- the area of the focal watershed
- the predominant land cover classes (top 4, by percent coverage) in the watershed, based on land cover classification data (see Land Use / Land Cover data below for more information)
- A list of the 5 most common fish species captured across sites within the watershed, based on site-specific fish observation data (see Site-level fish observations below for more information)

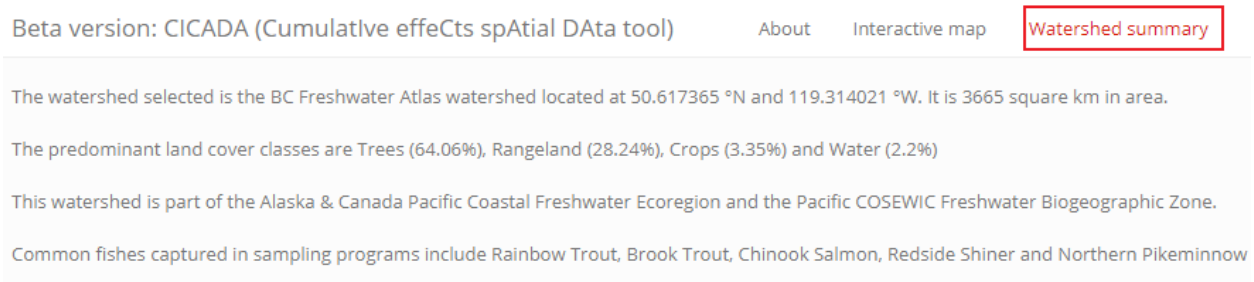

Figure 5. Watershed summary information provided in CICADA

FISH DATA

Fish present in watershed

A list of fish species present in the watershed is provided in the 'Fish species list' tab (Figure 6). These data are based on a compilation of several monitoring catch data sets and Anas and Mandrak (2022). The table columns are:

- Common_name: The common name of fish species present in the watershed. Note that regionally specific common names were retained for some species e.g., watersheds in British Columbia may have Sockeye and or Kokanee salmon
- Scientific_name: The scientific name of fish species present in the watershed
- Species_origin: with values of 'native', 'translocated' or 'foreign' describing whether the species is native to the watershed, is native to Canada but not to the focal watershed, or is not native to Canada, respectively

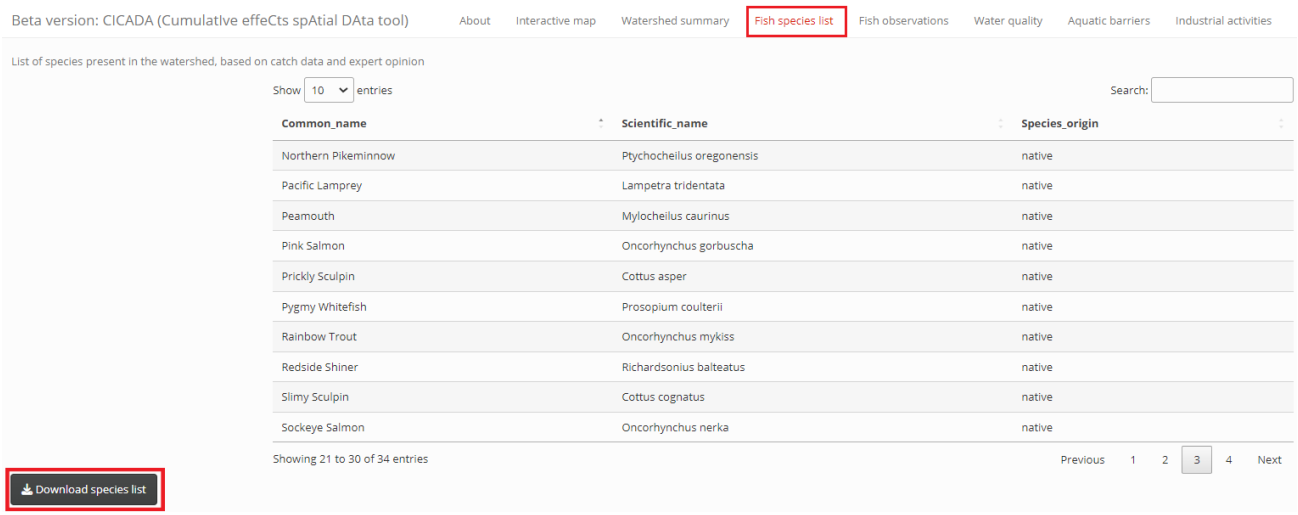

Figure 6. A species list of fishes present in the focal watershed provided by CICADA

A .csv file containing the data in the table is available for download via the ‘Download species list’ button on the bottom left of the page.

Note that fish species lists in CICADA are only available for NHN tertiary watersheds. If a provincial watershed unit scale is selected, CICADA will return the fish species list for the NHN tertiary watershed in which the focal site sits.

Site-level fish observations

Site-specific fish capture data are included in CICADA for over 240,000 sites across Canada (Figure 7). These data were compiled by the CICADA project team from a variety of provincial and regional datasets, which are detailed in Annex A.

The locations of the fish observations originate from fish sampling data available through online open data sources. Fish are present at many other sites beyond those included in the CICADA app. As such, the lack of a fish observation in CICADA at a focal site, should not be taken as evidence that fish (or a specific species of fish) is not present at that location.

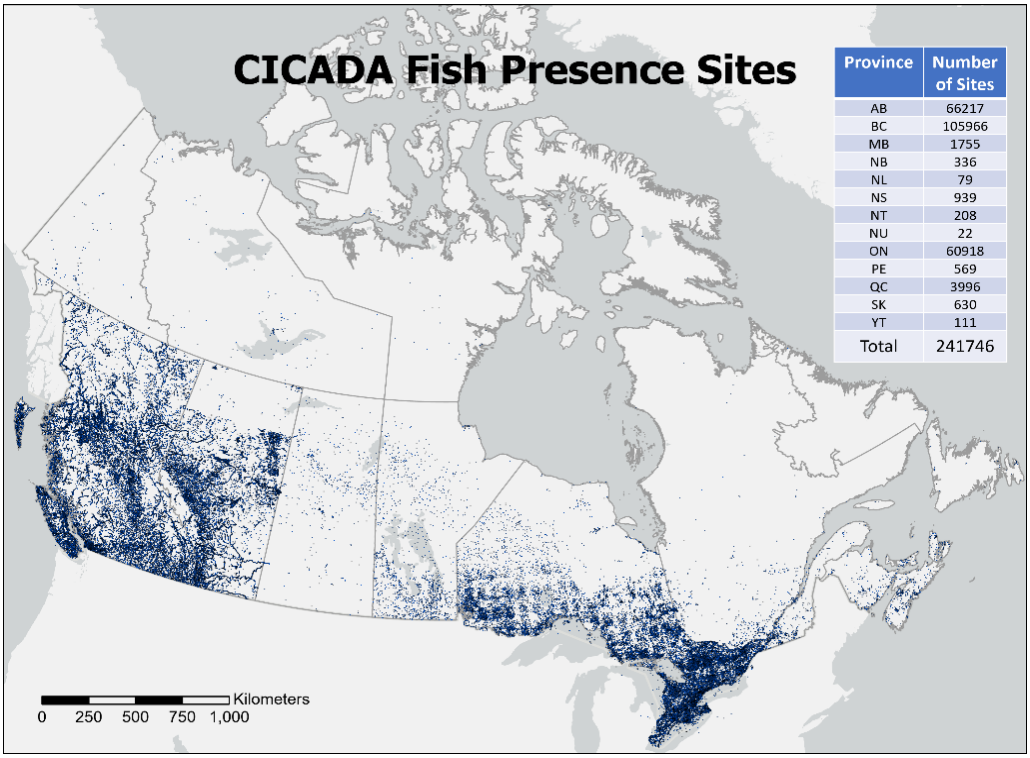

Figure 7. Sites with fish observation data within CICADA.

On the 'Interactive Map' tab of CICADA, selecting the 'Fish observations' checkbox in the map legend will display the fish observation sites for the focal watershed with green fish icons (Figure 8). Mousing over a site will show the list of species captured at that site.

In the 'Fish observations' tab, users will see a table containing information on the most recent capture of each species at each site. Table columns include:

- Common name: The common name of the fish species
- Scientific name: The scientific name of the fish species
- Site ID: A unique site ID for each sampling site, to help reference the information provided in the Interactive Map
- Last caught: The date that the fish species was most recently caught at that sampling site
- Latitude: The latitude of the sampling site, in WGS 1984
- Longitude: The longitude of the sampling site, in WGS 1984
- Waterbody name: The name of the waterbody in which the sampling site is located, if available

A .csv file containing the data in the table is available for download via the 'Download fish sampling data' button on the bottom left of the page.

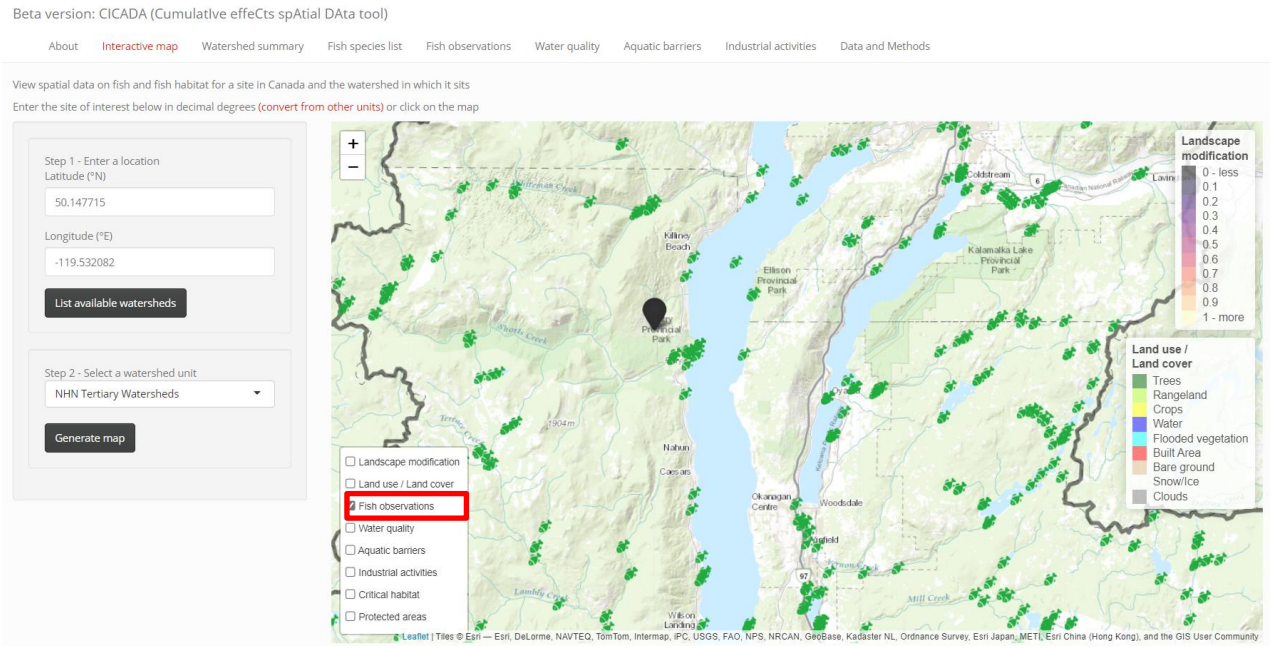

Figure 8. CICADA Interactive Map showing site-level fish observation data for a watershed near Kelowna, BC.

HABITAT DATA

Basemap

The basemap included in CICADA is the ESRI World Topographic Map vector tile (ESRI 2023). It includes a visualization of waterbodies and watercourses, topography, jurisdictional boundaries and basic land cover information. The basemap is compiled from a variety of authoritative sources including Canadian federal government datasets. However, users should be aware that very small features (e.g., very narrow watercourses or waterbodies such as ponds) may not be included in the basemap.

Land Use / Land Cover

Land use and land cover data are included in CICADA as a raster layer in the 'Interactive Map' tab and displayed by toggling the check box in the menu (Figure 9). Data were derived from ESA Sentinel-2 satellite imagery and pixels assigned to one of nine categories via a deep learning AI classification model trained on billions of human-labeled images (Karra et al. 2021). Possible classification values are:

- Water: Areas where water was predominantly present throughout the year; may not cover areas with sporadic or ephemeral water; contains little to no sparse vegetation, no rock outcrop nor built up features like docks; examples: rivers, ponds, lakes, oceans, flooded salt plains.

- Trees: Any significant clustering of tall (~15 feet or higher) dense vegetation, typically with a closed or dense canopy; examples: wooded vegetation, clusters of dense tall

vegetation within savannas, plantations, swamp or mangroves (dense/tall vegetation with ephemeral water or canopy too thick to detect water underneath).

- Flooded vegetation: Areas of any type of vegetation with obvious intermixing of water throughout a majority of the year; seasonally flooded area that is a mix of grass/shrub/trees/bare ground; examples: flooded mangroves, emergent vegetation, rice paddies and other heavily irrigated and inundated agriculture.

- Crops: Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land.

- Built Area: Human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings and residential housing; examples: houses, dense villages / towns / cities, paved roads, asphalt.

- Bare ground: Areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation; examples: exposed rock or soil, desert and sand dunes, dry salt flats/pans, dried lake beds, mines.

- Snow/Ice: Large homogenous areas of permanent snow or ice, typically only in mountain areas or highest latitudes; examples: glaciers, permanent snowpack, snow fields.

- Clouds: No land cover information due to persistent cloud cover.

- Rangeland: Open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting (i.e., not a plotted field); examples: natural meadows and fields with sparse to no tree cover, open savanna with few to no trees, parks/golf courses/lawns, pastures. Mix of small clusters of plants or single plants dispersed on a landscape that shows exposed soil or rock; scrub-filled clearings within dense forests that are clearly not taller than trees; examples: moderate to sparse cover of bushes, shrubs and tufts of grass, savannas with very sparse grasses, trees or other plants.

Cell classifications are indicated by the legend on right side of the ‘Interactive Map’ tab.

For most watersheds, the resolution of the land use / land cover rasters in CICADA is 30m x 30 m. A small number of northern watersheds are too large to map at such fine resolution, and were downsampled to 100m x 100m for display. Features that are smaller than this size will not be well represented in the layer. Furthermore, some pixels may be misclassified through the automated classification methods, which had an 85% accuracy across a variety of exemplar datasets (Karra et al. 2021) .

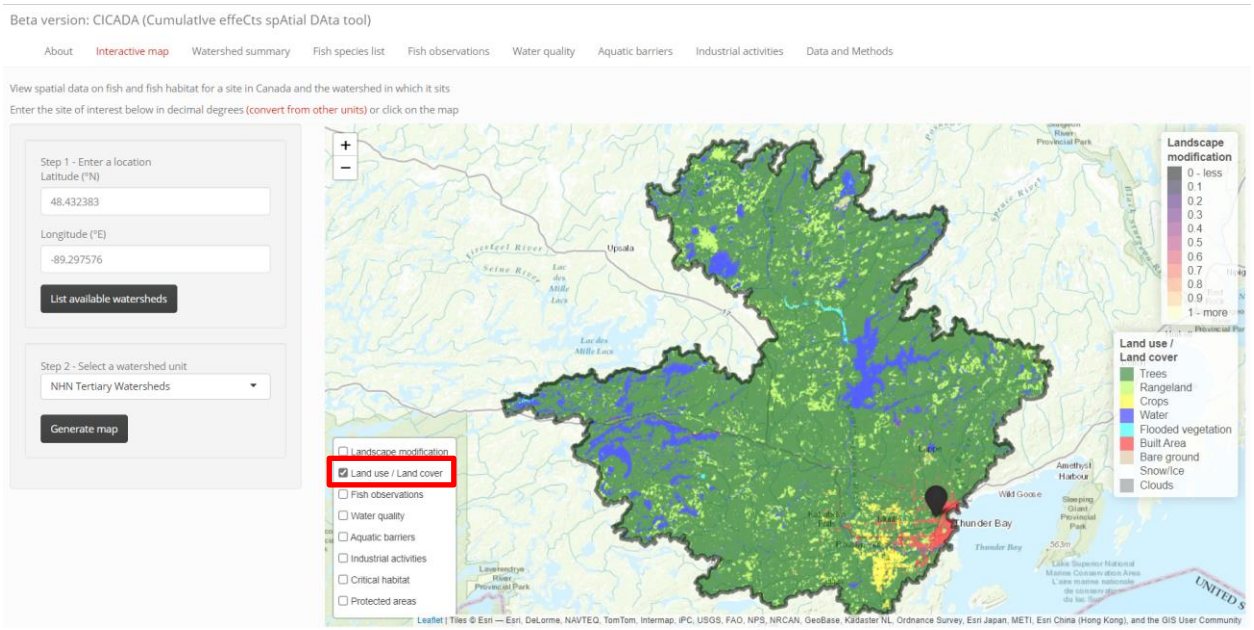

Figure 9. Land use / land cover information for a watershed near Thunder Bay, Ontario.

Species at Risk Critical Habitat

Areas designated as critical habitat for fish or mussels under the *Species at Risk Act (2002)* are displayed in CICADA as red polygons by toggling the corresponding check box in the menu (Figure 10). Any critical habitat polygon that intersects with the focal watershed is displayed therefore, some of the displayed critical habitat may lie outside of the focal watershed.

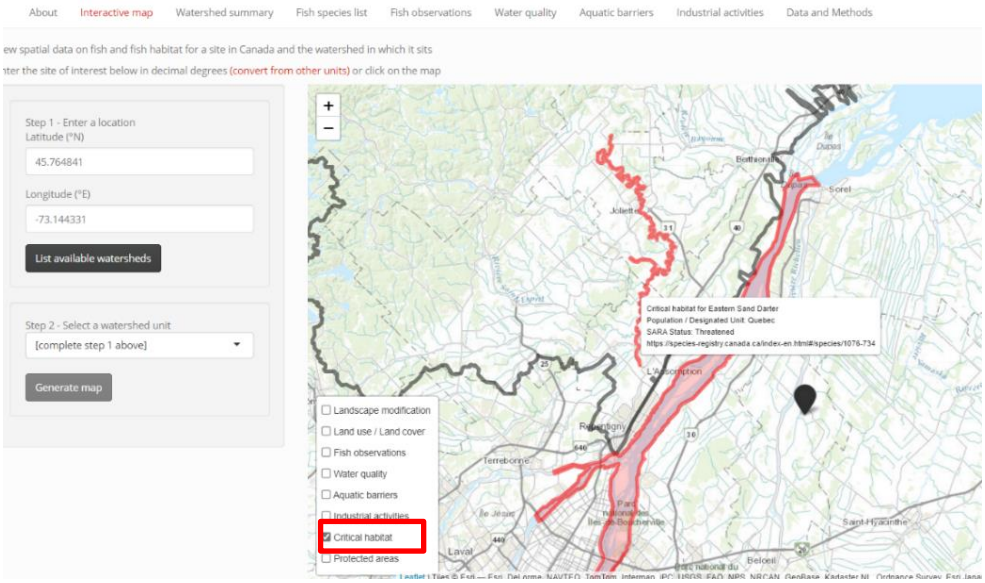

Figure 10. Species at risk critical habitat polygons displayed in CICADA

Mousing over the critical habitat provides information on the species name and designated unit (if applicable) that corresponds to the displayed polygon, as well as the *Species at Risk Act (2002)* Schedule I status.

Data were downloaded from the Government of Canada Open Data Portal – Critical Habitat of Species at Risk site, and filtered for freshwater and anadromous species (i.e., marine species were removed). All areas designated as critical habitat (up until May 2023) for freshwater fish and mussels are included within this layer, and therefore the absence of critical habitat within a focal watershed in CICADA is indicative of a true absence of critical habitat.

Protected Areas

Protected areas are displayed in CICADA with green polygons by toggling the corresponding check box in the menu (Figure 11). Any protected area polygons that intersects with the focal watershed are displayed, therefore some of the displayed protected area polygons may lie outside of the focal watershed. Mousing over a polygon displays the name, type and owner of the protected area, when those data were available. Data were downloaded from the Canadian Protected and Conserved Areas Database's December 2022 release. All areas considered as protected areas or other area-based conservation measures (OECMs) per the CPCAD User Manual, and reported by the responsible national and subnational jurisdictions are included in this layer, and therefore the absence of protected areas within a focal watershed are indicative of a true absence.

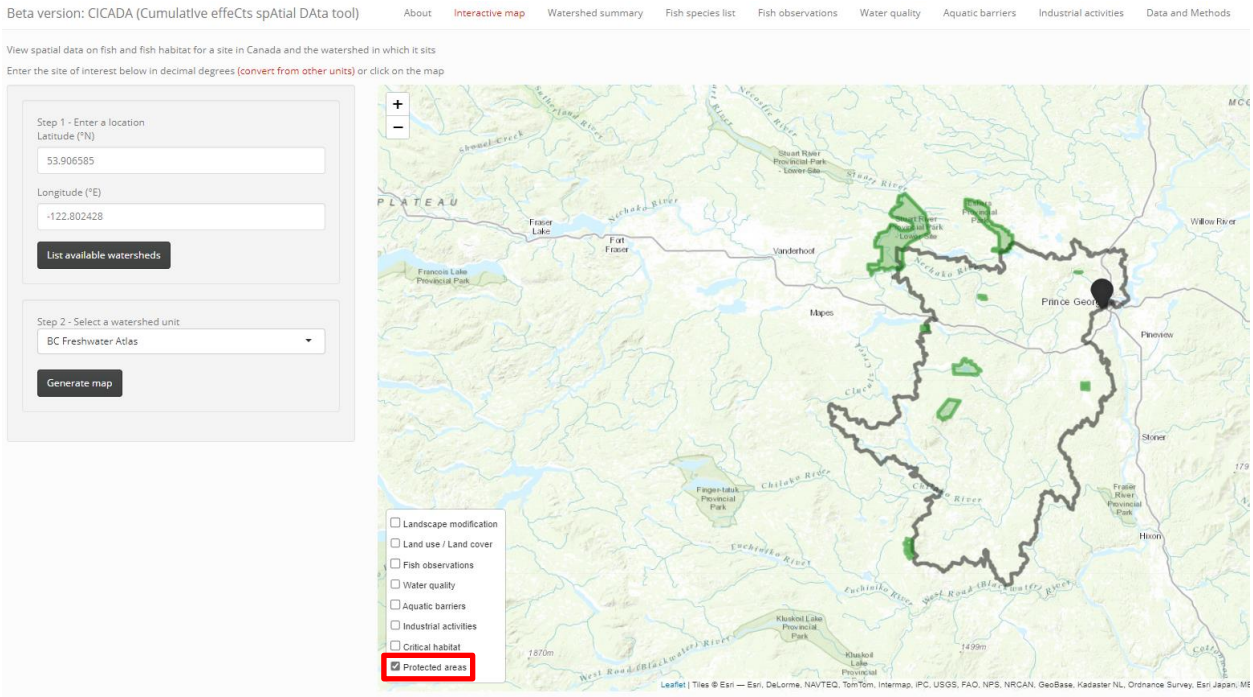

Figure 11. Protected areas displayed in CICADA for a watershed near Prince George, BC

Water quality

CICADA provides water quality data for over 15,000 sites across Canada. These data were compiled by the CICADA project team from a variety of provincial and regional datasets, which are detailed in Annex B.

In the 'Water Quality' tab, measured values of 11 water quality parameters are displayed in tabular format. Each row in the table represents an individual sampling event, such that multiple rows will be present for each site. Table columns include:

- Site_ID: A unique site ID for each water sampling site

- Latitude: the latitude of the sampling site, in WGS 1984
- Longitude: the longitude of the sampling site, in WGS 1984
- Date: the date of the sampling event
- Temp_C: the measured water temperature, in degrees Celcius
- Dissolved_chloride_mgL: the measured dissolved chloride concentration, in milligrams per L
- Dissolved_oxygen_mgL: the measured dissolved oxygen concentration, in milligrams per L
- pH: the measured pH
- Turbidity_NTU: the measured turbidity, in nephelometric turbidity units
- Conductivity_uSCM: the measured specific conductance, in micro Siemens per centimeter
- Nitrates_mgNO3NL: the measured nitrate concentration, in milligrams of nitrate-nitrogen per liter
- Total_phosphorus_ugL: the measured total phosphorus concentration, in micrograms per liter
- Selenium_Total_ugL: the measured total selenium concentration, in micrograms per liter
- Selenium_Dissolved_ugL: the measured dissolved selenium concentration, in micrograms per liter
- Total_dissolved_solids_mgL: the measured total dissolved solids, in milligrams per liter

On the 'Interactive Map' tab, selecting the 'Water quality' checkbox in the map legend will display the sites for which water quality information is available, with a water droplet icon. Grey colored icons indicate that some water quality information is available for a site, but there was insufficient data available to calculate a water quality index (see below).

Colored icons indicate that there was sufficient information to calculate a water quality index at a site. The water quality index in CICADA is based on the methods in the CCME Water Quality Index User's Manual 2017 Update, and gives a score between 0 (low quality) and 100 (high quality) based on the frequency, scope and amplitude by which water quality guidelines failed to be met. The specific coloration of the icon depends on the water quality index score, based on Table 1.

Table 1. Water quality index scores in CICADA and how they are displayed

Icon	Water quality description	Water quality index
	Excellent	95-100
	Good	80-94
	Fair	65-79

	Marginal	45-64
	Poor	0-44

In order to a calculate the water quality index, we focused on 7 water quality parameters for which specific guidelines were available (Table 2; Environment and Climate Change Canada 2023). We included water quality measurements taken from January 1, 2000 onwards and only calculated a WQI at a site if: i) the site had been sampled for longer than 1 year, ii) the site had been sampled at least 4 times per year through the sampling period, and iii) at least 4 different water parameters from Table 2 had been measured and met criteria i) and ii).

Table 2. Parameters and guideline values used in the calculate of the water quality index in CICADA

Water parameter	Guideline used in CICADA WQI Calculation	Source
Dissolved oxygen	> 6.5 mg/L	Canadian Council of Ministers of the Environment, 1999
Dissolved chloride	< 120 mg/L	Canadian Council of Ministers of the Environment, 2011
pH	6.5 - 9	Canadian Council of Ministers of the Environment, 1987
Total phosphorus	< 30 ug/L	Environment and Climate Change Canada, 2023
Nitrates	2.93 mg NO_3·N/L	Canadian Council of Ministers of the Environment, 2012
Total selenium	< 2 ug/L	Government of Canada, 2008
Turbidity	<10 NTU	Environment and Climate Change Canada, 2023

A lack of water quality information for a specific watercourse or waterbody does not imply that water quality is good at the site. Moreover, water quality may show complex seasonal fluctuations that are not well represented in single water quality index values or categories, and specific unmeasured water parameters within a system may be harmful to aquatic life despite a categorization of good/excellent based on the available data.

STRESSOR DATA

Landscape modification index

The extent of human modification to the landscape is included in CICADA as a raster layer, and can be displayed by selecting the ‘Landscape modification’ checkbox in the legend on the ‘Interactive map’ tab (Figure 12).

The layer illustrates the intensity of landscape modification, on a scale from 0 (no modification – dark coloration) to 1 (maximal modification – light coloration). Cell values were calculated by Theobald et al. (2020) and are based on the footprint of a variety of stressors including built

areas, agriculture, energy production and mining, transportation and service corridors, biological harvesting (e.g., forestry), human intrusions, natural system modifications and pollution. Cell values indicate landscape modification as of 2017, and are presented at a 300 m x 300 m resolution.

Contributing datasets are largely from satellite missions, or based on global databases. As such, national coverage in Canada is good. However, stressors newer than 2017 will not be represented, some of the contributing datasets may have missing features, and some stressor categories are not included in the index due to incomplete global coverage or coarse mapping units (Theobald et al. 2020). Furthermore, the specific relationship (i.e., the shape of the response curve) between landscape modification and aquatic ecosystem health is not clear.

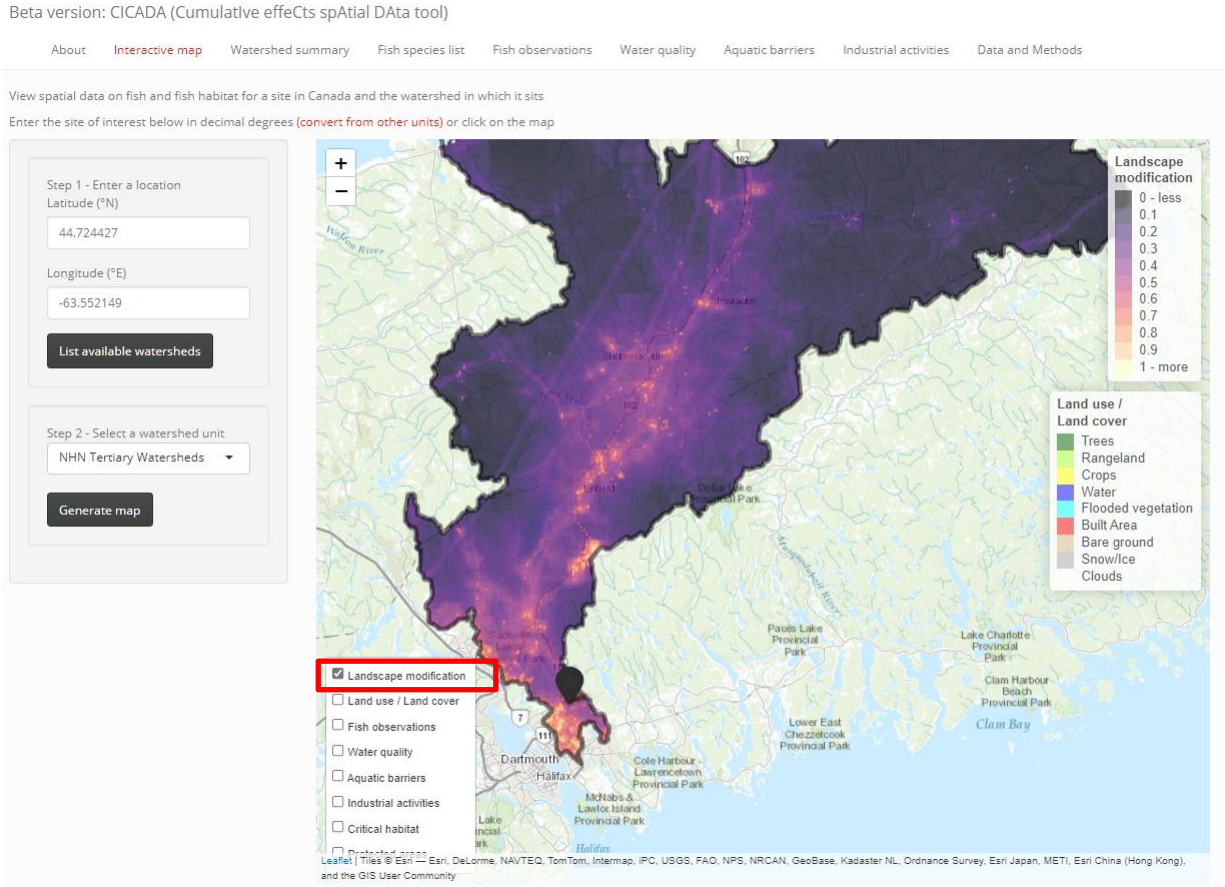

Figure 12. Landscape modification information is shown on a scale of 0 (no modification) to 1 (maximum medication) for a watershed near Halifax, NS.

Barriers in aquatic systems

Data on barriers in aquatic systems are provided in CICADA (Figure 13), and are based on the Canadian Wildlife Federation's Canadian Aquatic Barrier Database, which has compiled over 100 datasets relating to aquatic barriers in Canada. While these data represent the most comprehensive data on barriers in aquatic systems in Canada, they are not complete. As such, the absence of aquatic barriers within the CICADA is not necessarily indicative of a true absence of barriers.

In the 'Interactive Map' tab, selecting 'Aquatic barriers' from the legend will display locations associated with aquatic barriers, with red squares indicating dams, blue squares indicating

waterfalls, and green squares indicating fishways. Mousing over the icons will display a unique ID number for the barrier, and information on height, use and passability, where it is available.

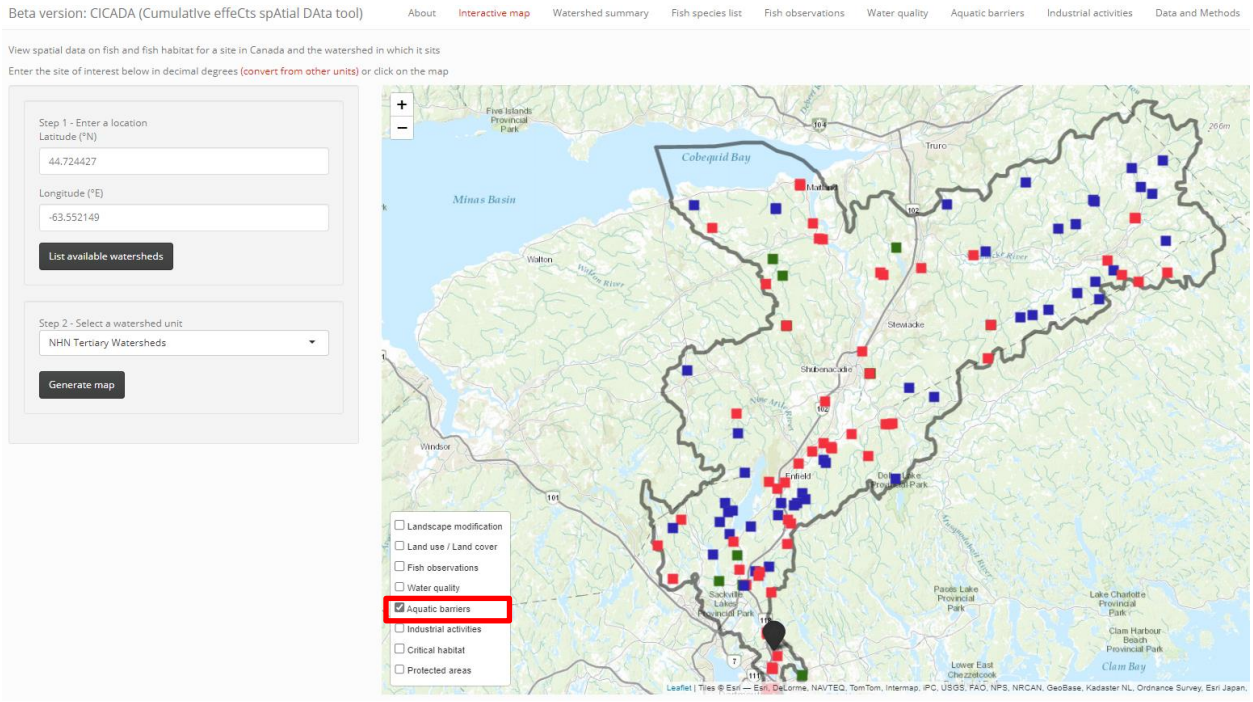

Figure 13. Information on aquatic barriers is provided in the Interactive Map and in the Aquatic Barriers tab.

Selecting the ‘Aquatic barriers’ tab at the top of the CICADA window will display the same information in a tabular format. The complete set of aquatic barrier information for the focal watershed can be downloaded using the ‘Download barrier button’ in the bottom left of the ‘Aquatic barriers’ tab.

Industrial activities

Information on current, former or planned industrial activities within the focal watershed are provided by CICADA.

Clicking on the ‘Industrial activities’ checkbox on the ‘Interactive map’ tab displays sites associated with industrial activities (Figure 14). The symbology follows Table 3.

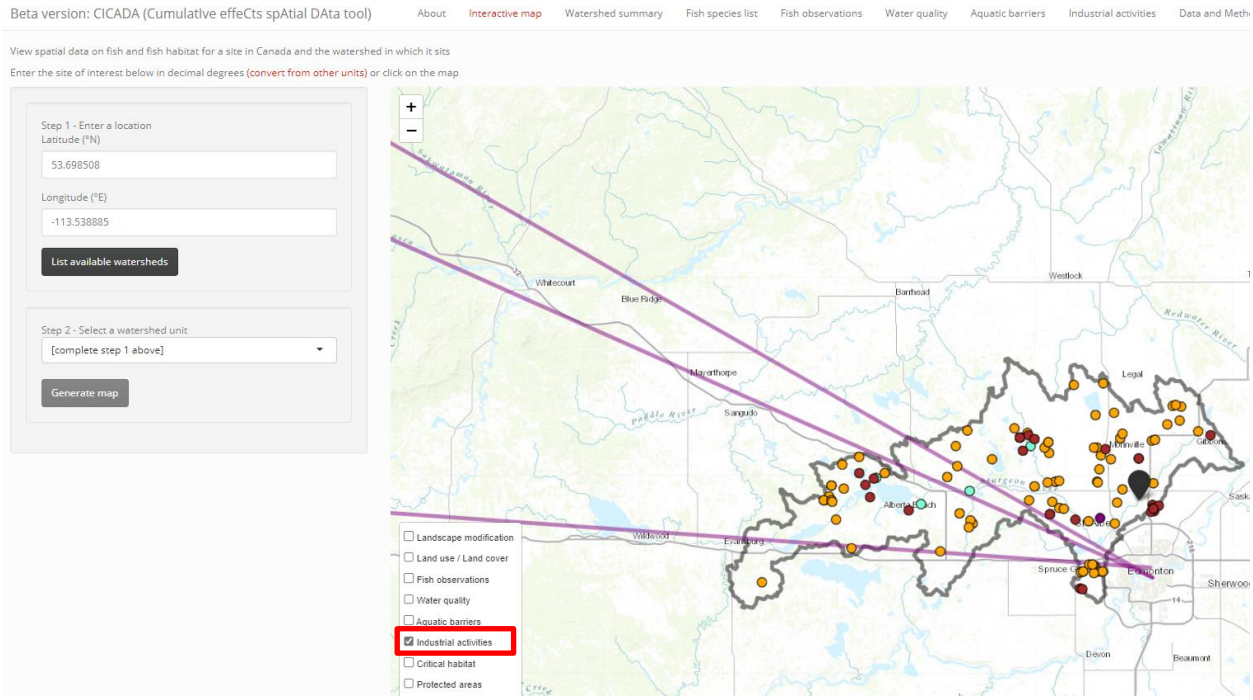

Figure 14. Current, former and planned industrial activities for a watershed near Edmonton, Alberta. Note that all industrial activities are point locations, except planned major projects (purple symbols) which may include sites or lines (e.g., linear features such as planned pipelines).

Table 3. Symbology for industrial activities in CICADA

Symbol	Feature	Source
	Producing mines	NRCan 2023
	Oil and gas sites	NRCan 2023
	Metalwork sites	NRCan 2023
	National Pollutant Release Inventory sites	ECCC 2023
	Wastewater Systems Effluent Regulations sites	ECCC 2022
	Federal Contaminated Sites Inventory sites	TBS 2023
or	(Planned) Major Projects Inventory	NRCan 2023

Mousing over sites provides additional information on the industrial activity, including information on the name, status, site owner, and known pollutant or effluent releases, when available.

All datasets are national in nature and should therefore have few missing features. As such, an absence of a feature type within CICADA should constitute reasonable evidence that such a feature is truly absent from the focal watershed.

Clicking on the ‘Industrial activities’ tab in the top banner of CICADA will display data on industrial activities in a tabular format. Columns in this table include:

- Facility_Type: the type of industrial activity or facility
- Name: the name of the site
- Owner: the owner of the facility, or the responsible department in the case of federal contaminated sites
- Latitude: the latitude of the site, in WGS 1984.
- Longitude: the longitude of the site, in WGS 1984.
- Description: additional information on the facility, as provided through the data sources reference in Table 3. This may include additional information on the facility’s operations or when pollutant release data was last provided to the National Pollutant Release Inventory database
- Known_Releases: a list of known pollutant releases, or the average daily effluent release in the case of wastewater facilities

The full table of industrial activity information can be downloaded by clicking on the ‘Download industrial activities’ button on the bottom left of the page.

ACKNOWLEDGEMENTS

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ANNEX A

Data sources for site-level fish observations

Name	Source	Coverage
Fisheries and Wildlife Management Information System	Alberta Environment and Parks	Alberta
iNaturalist	iNaturalist	National
Fish stocking report	Alberta Environment and Parks	Alberta
Contaminants in fish database	DFO	National
BOLD Systems Fish Species Location Data	BOLD Systems	National
Clean Air Regulatory Agenda Freshwater Inventory and Surveillance of Mercury	ECCC	National
Wild Fish Health, Oil Sands Region	ECCC	Alberta
Enhanced Monitoring of the Lower Athabasca River	Alberta Environment and Parks	Alberta
BC Historical Fish Distribution	Government of British Columbia	British Columbia
Known BC Fish Observations and BC Fish Distributions	Government of British Columbia	British Columbia
Aquatic Invasive Species of British Columbia	Government of British Columbia	British Columbia
BOLD Systems Lamprey Species Location Data	BOLD Systems	National
Fish community and fish habitat inventory of streams and constructed drains throughout agricultural areas of Manitoba	DFO	Manitoba
Pelagic Fish Trawl Survey of Lake Winnipeg	DFO	Manitoba
Trophic structure and mercury transfer in the subarctic fish community of Great Slave Lake, Northwest Territories, Canada	Academic	Northwest Territories
Fishery resources and habitats in a headwater lake of the Brock River, Northwest Territories	DFO	Northwest Territories
Commercial harvest of Arctic Char at the Halokvik River	DFO	Nunavut
Arctic Char biological data using a weir in Halokvik River, Nunavut	DFO	Nunavut
Ontario Fish Presence Absence data	DFO	Ontario
Fish Community Records	Toronto Regional Conservation Authority	Ontario
Fish Community - Prince Edward Island	Government of Prince Edward Island	Prince Edward Island

iNaturalist SK Community Conservation Data	iNaturalist	Saskatchewan
Piscivorous Fish Population and Structure - Prince Albert	Parks Canada	Saskatchewan
Dolly Varden Harvest Monitoring	DFO	Northwest Territories

ANNEX B

Data sources for water quality data

Name	Source	Coverage
Longterm Water Quality Monitoring Program for Lakes	Alberta Environment and Parks	Alberta
LakeKeepers Water Quality Data	Alberta Lake Management Society	Alberta
Upper Athabasca Community Based Monitoring	Upper Athabasca Community Based Monitoring	Alberta
LakeWatch Water Quality Data	Alberta Lake Management Society	Alberta
Lesser Slave Watershed Council Tributary Monitoring Program	Lesser Slave Watershed Council	Alberta
Acid Sensitive Lakes, Oil Sands Region	ECCC	Alberta, Saskatchewan and Northwest Territories
RAMP Water Quality	Regional Aquatics Monitoring Program	Alberta
Long Term River Station Data	Alberta Environment and Parks	Alberta
Oil Sands Monitoring - Surface Water Quality Wetland 2017-2020	Alberta Environment and Parks	Alberta
Tributary Water Quality - Oil Sands Region	Environment and Climate Change Canada	Alberta
Athabasca Basin: Tailing Ponds and Impacts on Aquifers	Alberta Environment and Parks	Alberta
Mainstem Athabasca Benthic Invertebrates - Major Ions Physicals 2011-2017	Environment and Climate Change Canada	Alberta
Expanded Geographic Extent, Oil Sands Region Water Quaity Monitoring	Environment and Climate Change Canada	Alberta
Acid Sensitive Lakes, Oil Sands Region	Environment and Climate Change Canada	Alberta
Deltaic Ecosystem Health, Benthic Invertebrate Major Ions	Environment and Climate Change Canada	Alberta
Peace - Athabasca River Basin Long-Term Water Quality Monitoring Data	Environment and Climate Change Canada	Alberta
Pine Lake Water Quality Monitoring Data	Wood Buffalo National Park	Alberta
Water Quality of Seven Persons Creek	South East Alberta Watershed Alliance	Alberta
CreekWatch Citizen Science	RiverWatch Institute of Alberta	Alberta
Surface Water Quality Data	City of Calgary	Alberta

Kananaskis River Environmental Science Program	University of Calgary	Alberta
Friends of Fish Creek Water Quality Monitoring Program	Friends of Fish Creek Provincial Park Society	Alberta
Bragg Creek Water Quality Monitoring	Bragg Creek Water Quality Monitoring Collective	Alberta
Bighill Creek Water Quality Data	Bighill Creek Preservation Society	Alberta
Ghost Watershed Water Quality Monitoring Program	Ghost Watershed Alliance Society	Alberta
North Saskatchewan River Tributary Monitoring Network Program	Alberta Environment and Parks	Alberta
North Saskatchewan River Basin Long Term River Network Program	Alberta Environment and Parks	Alberta
Vermilion River and Stretton Creek Water Quality at Low Flow	North Saskatchewan Watershed Alliance	Alberta
Carvel Pitted Delta Lakes Survey	Alberta Lake Management Society	Alberta
Sturgeon River Ecosystem Assessment Report	North Saskatchewan Watershed Alliance	Alberta
Lac La Biche County Lake Water Quality Monitoring Program	Lac La Biche County	Alberta
BC Environmental Monitoring System	Government of British Columbia	British Columbia
Peace River Regional District Water Quality Baseline	Municipality of Hudson's Hope	British Columbia
Fort Nelson First Nation Water Quality Monitoring	Fort Nelson First Nation	British Columbia
Wildsight Creston Valley Goat River Monitoring	Wildsight Creston Valley	British Columbia
Slocan Park CARE Society Water Quality Monitoring Program	Slocan Park CARE Society	British Columbia
Slocan River Water Quality Monitoring	Slocan River Streamkeepers Society	British Columbia
Wilson Creek Water Quality Monitoring	Slocan Lake Stewardship Society	British Columbia
Lake Windermere Ambassadors Water Quality Monitoring	Lake Windermere Ambassadors	British Columbia
NWT-wide Community-based Monitoring Program	Government of the Northwest Territories	Northwest Territories
Community Based Monitoring of Kakisa River watershed	K'agee Tu First Nation	Northwest Territories
Dehcho Region Water Quality	University of Waterloo	Northwest Territories
The impact of wildfire on diverse aquatic ecosystems of the NWT	Government of the Northwest Territories	Northwest Territories
The Impacts of Recent Wildfires on Northern Stream Ecosystems	Brock University	Northwest Territories

The influence of forest fires on metal deposition to lakes and peatlands in the North Slave Region, NWT	Environment and Climate Change Canada	Northwest Territories
Changes in dissolved organic carbon quality and quantity: Implications for aquatic ecosystems and drinking water quality for northern communities	University of Waterloo	Northwest Territories
Legacy arsenic pollution in Yellowknife Bay sediments	Government of the Northwest Territories	Northwest Territories
Changing hydrology in the Taiga Shield - Geochemical and resource management implications	Government of the Northwest Territories	Northwest Territories
Understanding changes in aquatic ecosystem health and water quality in the Fort Good Hope, Ramparts Area	Kirsty Gurney	Northwest Territories
Fort McPherson-Inuvik-Tuktoyaktuk Transportation Corridor Water Quality Monitoring	Wilfrid Laurier University	Northwest Territories
Development of a Biological Monitoring Program to Detect Change in Stream Health Along the Dempster–Inuvik–Tuktoyaktuk-Corridor	Wilfrid Laurier University	Northwest Territories
Water Quality - Tuktut	Parks Canada	Northwest Territories
Swift Current Creek Watershed Stewards Phosphorus Monitoring	Swift Current Creek Watershed Stewards	Saskatchewan
South Saskatchewan River Stewards Phosphorus Monitoring	South Saskatchewan River Watershed Stewards	Saskatchewan
Carrot River Watershed Association Monitoring Program	Carrot River Valley Watershed Association	Saskatchewan
NSRBC Water Quality Data	North Saskatchewan River Basin Council	Saskatchewan
Lower Saskatchewan - Nelson River Basin Long-term Water Quality Monitoring	Environment and Climate Change Canada	Saskatchewan
Yukon Basin WQ Field Measurements and Laboratory Analysis	U.S. Geological Survey	Yukon
Yukon River Basin Long-term Water Quality Monitoring Data	Environment and Climate Change Canada	Yukon
Ivvavik Park Water Quality Monitoring	Parks Canada	Yukon
Provincial Stream Water Quality Monitoring Network	Ontario Ministry of Natural Resources and Forestry	Ontario
East Interlake Watershed District Quarterly Sampling	Government of Manitoba	Manitoba
FortWhyte Alive Watershed Project	FortWhyte Alive	Manitoba

Long Term Water Quality Monitoring Program	Government of Manitoba	Manitoba
Lake Winnipeg Chemistry	Fisheries and Oceans Canada	Manitoba
Manitoba Water Quality Monitoring	South Central Eco Institute	Manitoba
Lake Winnipeg Community-Based Monitoring Network	Lake Winnipeg Foundation	Manitoba
Fish Community and Fish Habitat Inventory of Streams and Constructed Drains Throughout Agricultural Areas of Manitoba	Fisheries and Oceans Canada	Manitoba
Environmental Nutrient Budget Kerr Lake	Little Saskatchewan River Conservation District	Manitoba
Environmental Water Quality Monitoring Program	Municipality of Yellowhead	Manitoba
PEI Surface Water Quality Monitoring Program data	Government of Prince Edward Island	Prince Edward Island
Water Quality in Canadian Rivers	Environment and Climate Change Canada	National