NatureServe Canada's
Ecosystem-based Automated Range (EBAR)
Methods

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Background

NatureServe Canada's Ecosystem-based Automated Ranges (EBAR) aim to produce trusted and publicly accessible range data and maps for priority species.

The objectives of the project are to develop range data and maps that:

- Incorporate the best available species occurrence information.
- Can be reviewed and refined by species experts in an ongoing and efficient manner.
- Provide access to reference information for the underlying occurrence data.
- Are available at no charge.
- Are provided in an electronic format that permit efficient customization and uptake by biodiversity experts, organizations and decision-makers.

EBAR uses jurisdiction-provided ecoshapes (polygons of ecoregions, ecodistricts, or other representations of ecosystems) that eliminate the need to manually draw or edit species range boundaries. The ranges use biodiversity information and expert knowledge to populate the ecoshapes with species presence values. Each ecoshape in a species range is associated with references to the underlying occurrence data without displaying the precise species locations. This provides transparency while protecting sensitive species information.

Ranges were reviewed by species experts using the EBAR Reviewer online tool. This tool allows species experts to efficiently contribute their knowledge toward reviewing and providing feedback on EBAR maps, thus contributing to map improvements on an ongoing basis. This review is critical for filling data gaps in the “automated” EBAR maps, particularly for lesser known and rare species.

EBAR differs from traditional range maps as they:

- Use predefined base linework (ecoshapes) that eliminate the need to draw or edit range boundaries resulting in a more efficient and repeatable range production process
- Automate generation of ranges allowing for continual improvement as new data or expertise is available
- Provide a web-based means to collect expert review
- Provide references to the underlying occurrence data

NatureServe Canada will make EBAR species ranges publicly available online at no cost. The published ranges will be file formats that facilitate integration into Geographic Information System (GIS) software allowing uptake and customization by a wide variety of end-users including industrial environmental impact assessments, federal, provincial and territorial species at risk programs, and government bodies responsible for land use planning.

Contact

For questions, feedback, and technical support please contact the team at EBAR-KBA@natureserve.ca.

Acknowledgments

EBAR was developed based on the work of the Northwest Territories, British Columbia, Wyoming and Oregon NatureServe Programs.

We would like to thank the NatureServe Map of Biodiversity Importance (MoBI) and NABA projects for sharing their knowledge, expertise, and code with us. The EBAR Reviewer app would not be possible without them.

We would like to thank all the individuals and institutions who shared data to ensure EBAR is based on the best available information.

Finally, we thank the species experts who kindly shared their time and expertise to review ranges and provide feedback on if they are reliable and accurate.

Citation

If you would like to use EBAR species ranges in a project or products, please use the following citation:

Multiple species:
NatureServe Canada. 2020. Ecosystem-based Automated Range (EBAR). Ottawa, Canada. Retrieved on [insert date] from [insert url]

Single species:
NatureServe Canada. 2020. [insert species name] Ecosystem-based Automated Range (EBAR). Ottawa, Canada. Retrieved on [insert date] from [insert url]

Overview

The steps used to develop EBAR data and maps are briefly described below and illustrated in Figure 1. These are explained in greater detail later in the document.

1. Ecoshape Mosaic: EBAR is built on the ecoshape mosaic which is a combination of ecoregions, ecodistricts or other representation of ecosystems. Currently this mosaic includes Canada, the continental US, and Mexico.

2. Species Occurrences: species occurrence information was mined from many sources including Conservation Data Centres, provincial, territorial and federal governments, citizen science platforms, digital biodiversity data resources,

iNaturalist, academia, museums, non-governmental organizations, industry, and species experts. Each species range includes the list of sources with references used to produce the range in the metadata.

3. Auto-generated Range: geoprocessing tools built with Python code were used to automatically populate ecoshapes with a presence value (present, presence expected or historical) based on the species occurrence data underlying the ecoshape. For example, if all underlying data had an observation date greater than 40 years it was given a historical presence value.

4. EBAR Reviewer: an online app that allows species experts provide feedback securely and efficiently to refine and improve an auto-generated range.

5. Refine based on expert feedback: all feedback from species expert review is captured and applied to the auto-generated range (e.g. add or remove ecoshapes).

6. Publish: all ranges will be published at no charge on various platforms that allow for program specific customization. Currently EBAR data and maps are only available through NatureServe Canada's website (https://www.natureserve.org/natureserve-network/canada/biodiversity-data/ebar-range-mapping). We are working to include additional platforms.

7. Continual Improvement: as new data or expertise is available the range maps can easily be re-generated and new versions released

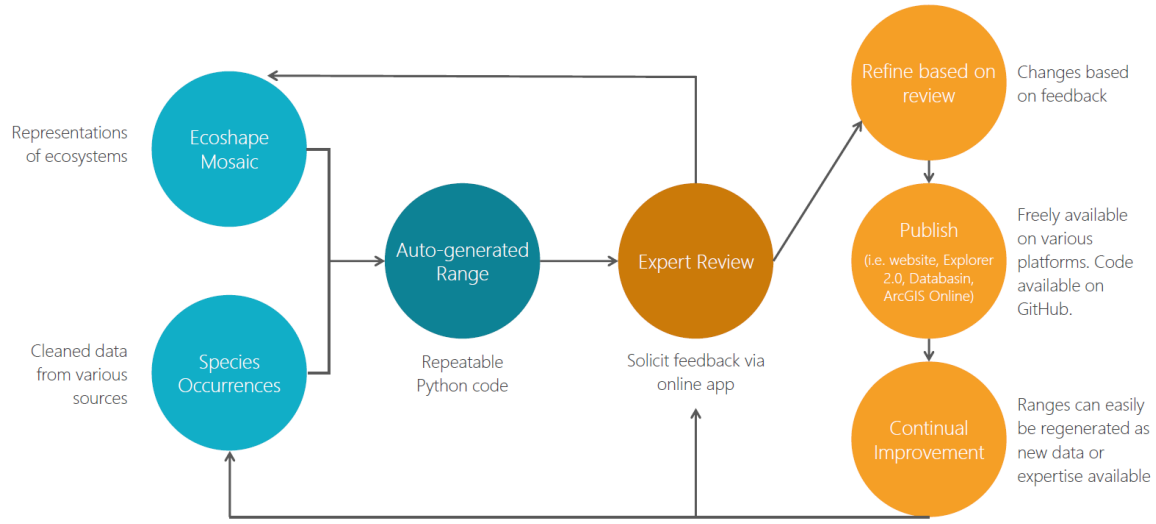


Figure 1. Overview of the EBAR map production process.

Ecoshapes

One of the challenges for EBAR was deciding what dataset to use as the basis for species ranges. The Canada-wide Ecosections (Ecological Stratification Working Group, 1995) was the only national dataset available at the appropriate scale in 2019, but many jurisdictions have updated the polygon line work since 1995 to address some of the inaccuracies in the line work. The EBAR team decided that, for the purposes of producing species ranges, regional accuracy is more important than country-wide consistency in line work.

The EBAR team reached out to the NatureServe Canada Network of Conservation Data Centres (CDC) and the Quebec CDC to determine what ecological data should be used for their jurisdiction. The criteria for jurisdictional data submissions were that the dataset cover the entire jurisdiction, were at a regional scale (1:250,000 – 1:1,500,000), and available in GIS format (i.e. Shapefile, File geodatabase, KML, geoJSON).

For Canada, datasets were received from British Columbia, Alberta, Saskatchewan, Ontario, Quebec, New Brunswick, Nova Scotia, Newfoundland, Labrador, Yukon, and the Northwest Territories. Nunavut, Prince Edward Island, and Manitoba opted to use the 1995 Canada-wide Ecodistricts. For a complete list of sources see Appendix 1.

The EBAR team did not contact CDCs in the United States or Mexico, however, spoke with relevant experts to determine the most appropriate line work for these jurisdictions. For the United States, we used the Environmental Protection Agency's Ecoregions of the Continental United States (2013) Level III (Alaska only) and Level IV (all other states). For Mexico, we used Ecorregiones terrestres de México (2008) from Instituto Nacional de Estadística, Geografía e Informática (INEGI). For a complete list of sources see Appendix 1.

Jurisdictions use slightly different versions of the same political boundaries and different resolutions of coastline; thus, the borders did not line up properly when the various datasets were combined. Alignment of the line work was done primarily by team members Jacqueline Clare (British Columbia Conservation Data Centre) and Randal Greene (NatureServe Canada). To request detailed methods please email the EBAR team (EBAR-KBA@natureserve.ca).

Species Selection

The focus of NatureServe Canada's EBAR range mapping work was priority species for the Canadian Key Biodiversity Areas (KBA) project (i.e., Global and National KBA trigger species). For information on the Canadian KBA initiative please visit: http://www.kbacanada.org/. Global KBA triggers were species with an International Union for Conservation of Nature (IUCN) status of Critically Endangered, Endangered, Vulnerable or NatureServe Global conservation status of Critically Imperiled (G1) or Imperiled (G2). National KBA triggers were species with a Committee on the Status of

Endangered Wildlife in Canada (COSEWIC) status of Endangered or Threatened or a NatureServe National conservation Status of Critically Imperiled (N1) or Imperiled (N2).

Due to limited resources EBAR ranges have not been created for all species that meet these criteria; instead, the team has focused on Global triggers and species identified as priorities by regional KBA leads. Bird, freshwater fish, and marine species were excluded from the priority list as other methods are being used by the Canadian KBA initiative to identify KBAs for these taxonomic groups.

Data Mining

EBAR auto-generated ranges were developed using the best available data. Species occurrence data were mined from the Conservation Data Centres, provincial, territorial and federal governments, citizen science platforms, digital biodiversity data resources, iNaturalist, iNaturalist.ca, academia, non-governmental organizations, industry, and species experts. R packages ('spocc', 'rbison, 'rgbif') were used to download data from digital biodiversity data resources (GBIF, iNaturalist.org, BISON, iDigBio, ecoengine, and VertNet). A list of the sources used to generate each range can be found in the metadata for each species range.

Please note that the R code used for data mining can be found at https://github.com/NatureServe-Canada/SpeciesDownload.

We did not have the resources to undertake digitization (e.g. museum records, historical records or academic literature), rather we focused on locating and including all available digital data for each species. We acknowledge that some sources may have been missed or were not available at time of range production.

We intend to continually refine EBAR species ranges as new data are identified and made available. If you are aware of data or would like to share a dataset, please email the EBAR team (EBAR-KBA@natureserve.ca). A current list of the species for which we are seeking data and/or expert review is maintained on the NatureServe Canada EBAR webpage.

Database and Server

The NatureServe Canada EBAR geodatabase is deployed on an ArcGIS Enterprise Server with a PostGIS geodatabase hosted on a Microsoft Azure virtual computer with a Canadian data centre.

The database contains sensitive information on species at risk; data may be covered by data sharing agreements or have data security requirements (e.g. data use training). Therefore, all data is given one of the following data security categories:

1) **Restricted EBAR Data**: can be accessed by data users who meet the data security requirements of data providers and who are NatureServe Canada EBAR Team members

2) **Restricted Data**: can be accessed by data users who meet the data security requirements of data providers
3) **Non-Restricted**: no data security requirements governing access to this data category. Note that most of the data is from public data platforms such as GBIF, BISON, and iNaturalist.

Data users must request access for the purpose of EBAR-KBA work and meet all the relevant data security requirements.

Data is imported to the database using geoprocessing tools built with Python code. To ensure we only use the highest quality data the following criteria were used to select data:

- Exclude data with an uncertainty distance greater than 32 km. This cutoff was selected since it is the largest possible iNaturalist obscured coordinate distance (which is 0.2 x 0.2 degrees); however, this cutoff was not applied to NatureServe Element Occurrences
- Retain duplicate records (e.g. if iDigBio and GBIF have the same museum record there is no way to automatically identify this and both records are retained)
- Include iNaturalist records that have a quality grade of “Research Grade”
- Exclude data without dates
- Exclude any fossil records
- Exclude any data missing location coordinates

Data was imported from many sources that use differing taxonomy. All taxonomy was standardized to NatureServe Canada’s Element National Scientific Name using geoprocessing tools built with Python code. To be imported, the species scientific name either needed to match the Element National Scientific Name or an accepted synonym. The taxonomy, including any synonyms or secondary species (e.g. infraspecies), used for the species range can be found in the metadata for each species range.

Please note that all Python geoprocessing code used to develop EBAR species ranges can be found at https://github.com/NatureServe-Canada/EBARTools.

Auto-generation

Geoprocessing tools built with Python code were used to auto-generate EBAR species ranges (Figure 2). The same ecoshape mosaic was used for all the ranges. Input data were stored separately as points, lines and polygons.

Species occurrence data were buffered by the uncertainty distance given by the data provider. If no uncertainty distance was reported points were buffered by 10 meters. Lines were buffered by 10 meters regardless of the reported uncertainty distance. This was done to allow the polygon-based algorithm to process all data types.

Ecoshapes were populated with one of the following presence values:

1) Present: the species is found within the ecoshape based on species observation data, Element Occurrences, Source Features, or expert opinion

2) Presence Expected: there are no known species observation data within the ecoshape, but the habitat is suitable for the species according to expert opinion, or the ecoshape overlapped with Canadian federal critical habitat, a range estimate, or a habitat suitability model

3) Historical: all species occurrence data within the ecoshape has an observation date greater than 40 years old or an Element Occurrence (EO) that was ranked as Extirpated or Historical (EO rank of H, H?, X or X?)

When multiple input data overlap an ecoshape the following rules were used, applied in top to bottom priority order:

DatasetType	EORank	MaxDate	Ecoshape Presence
Element Occurrences	NOT NULL AND NOT 'H', 'H?', 'X', 'X?', OR	<=40 years old	Present
Source Features		<=40 years old	Present
Species Observations		<=40 years old	Present
Critical Habitat			Present
Range Estimate			Presence Expected
Habitat Suitability			Presence Expected
Element Occurrences	'H', 'H?', 'X', 'X?'		Historical
Element Occurrences	NULL, AND	>40 years old	Historical
Source Features		>40 years old	Historical
Species Observations		>40 years old	Historical

Ranges were produced at various geographic scales (national, global, or North American), these are indicated in the Range Scope on the map and in the range metadata.

1) National: only includes ecoshapes for the species in Canada, although it is known to occur outside of Canada

2) Global: includes all the known ecoshapes for the species in the world

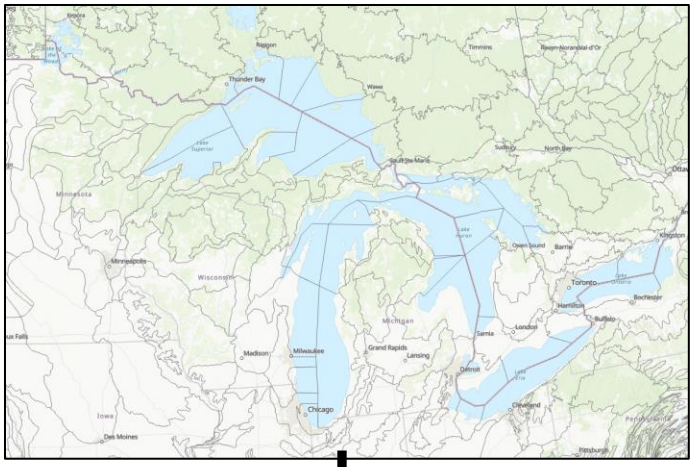
3) North American: only includes ecoshapes for the species in North America (Canada, the US and Mexico), although it is known to occur outside of North America (e.g. Europe or Asia)

The taxonomy used is defined as the ranges are auto-generated. Primary and secondary species, such as infraspecies, are specified and recorded on the map and in the range metadata. Additionally, specific records for species can be included or

excluded (e.g. all records for *Martes americana* in Newfoundland can be attributed to *Martes americana atrata*). Details of these inclusions and exclusions are made in the map notes and can be found in the range metadata.

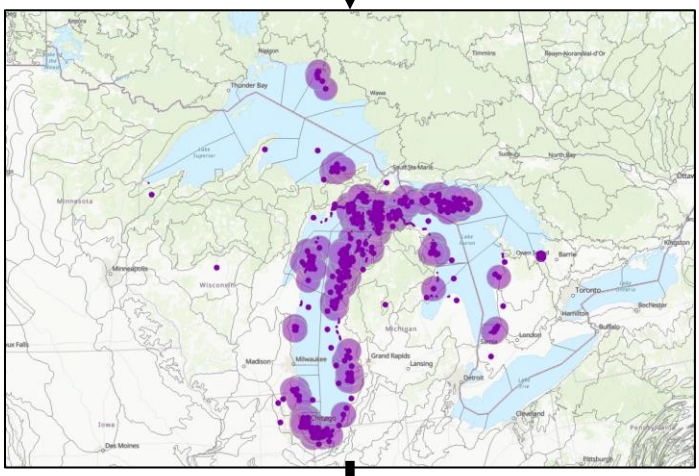
Ecoshape Mosaic

- Includes US, Canada and Mexico
- Polygons of ecoregions, ecodistricts or other representation of ecosystems
- Predefined base linework eliminates the need to manually draw or edit range boundaries



Species Data

- Use species occurrence data
- Point data buffered using uncertainty distance from data provider, if non provided used 10 meters



Auto-generated

- Use Python tools to populate ecoshapes with presence values (present, presence expected or historical)
- References to species occurrence data
- References provide transparency without displaying locations

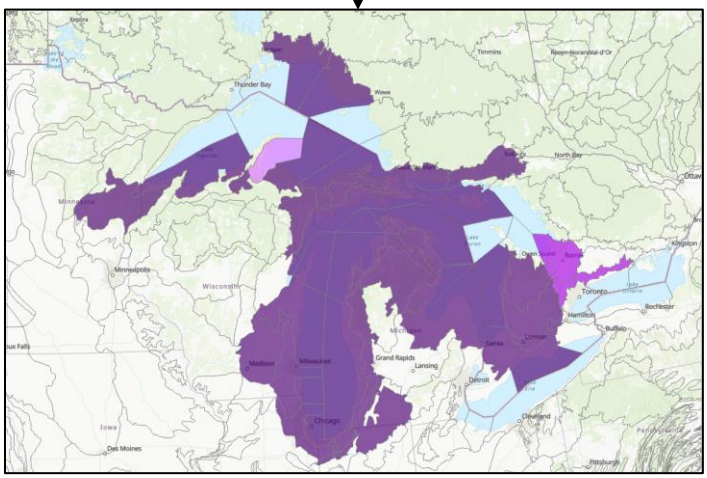


Figure 2. Overview of EBAR auto-generation process

Expert Review

An online EBAR map review tool (EBAR Reviewer) was developed with ESRI Canada, to collect feedback efficiently and securely from experts. The source code is available at https://github.com/NatureServe-Canada/EBARReviewer and is based on NatureServe's Map of Biodiversity review tool code. Expert reviewers were recruited based on their species expertise and the geographic extent of their knowledge.

We created a detailed user manual and instructional videos for expert reviewers. To request electronic versions please email the EBAR team (EBAR-KBA@natureserve.ca).

In brief, experts were assigned species and provided a unique login to the EBAR Reviewer app. Once logged in to app and a species is selected the experts can change the presence value for each ecoshape based on their expertise (e.g. change ecoshape presence status from historical to present or null to present expected). Experts must provide comments, and optionally a reference, to support their decision to modify the presence value of the ecoshape. Upon completion of their review/refinement of a given map experts are asked to provide a star rating (out of 5) to rate the quality of the map and provide comments to support their rating (e.g. missing data or does not accurately reflect species). The reviews are stored in the database. Once an entire range has been reviewed the changes are applied (e.g. ecoshapes are added or removed to the range). Experts are acknowledged in the range metadata.

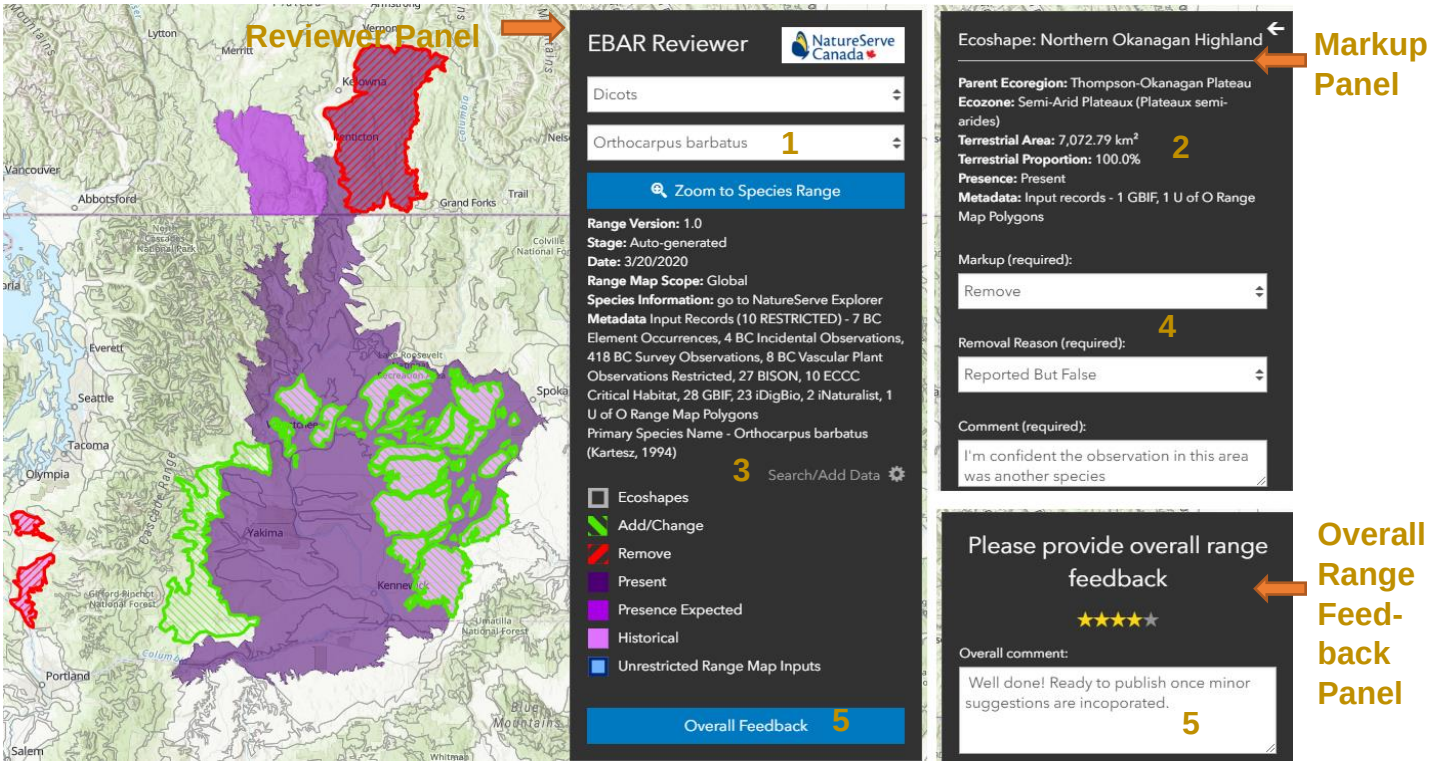


Figure 3. Screen shots from EBAR Reviewer showing main features that allow for expert review: 1) select species and view the range metadata, 2) select an ecoshape and view the species/ecoshape metadata, 3) optionally view non-restricted input data and temporarily view personal data, 4) markup ecoshapes by suggesting they be added or removed from the species range, or have their presence value changes, and 5) provide overall feedback on the species range.

Publication

EBAR species ranges will be made available at no cost on various public online platforms. Currently EBAR species ranges are available through the EBAR website [insert link], however we are working to make them available through additional public websites (e.g. NatureServe Explorer 2.0 or DataBasin).

EBAR species ranges are available in PDF format or as a geospatial data package with associated metadata.

We will release species ranges in batches as they are finalized. Please check the website regularly for new species ranges.

If you would like to use EBAR species ranges in a project or products, please use the citation format provided at the beginning of the document.

Funding to produce EBAR range maps for additional species

We are currently seeking funding to create ranges for priority species not covered by our KBA project funding (e.g., COSEWIC to be assessed/re-assessed, SARA-listed).

We are also seeking partners or funding to develop species ranges based on alternative base linework mosaics (e.g. marine or watershed polygons to produce ranges for aquatic species). Please reach out to the NatureServe Canada EBAR team if you would like to discuss project partnerships and funding opportunities (EBAR-KBA@natureserve.ca).

Frequently Asked Questions

I have a dataset I would like to share.

We request that the data are shared as a spreadsheet or shapefile that includes the following information, if possible: Date Observed, Name of Observer, Species Observed, Latitude, Longitude, Datum, and Accuracy of Location.

We would like to use the data for:

- Creating EBAR data and maps
- Future habitat suitability modelling work
- Key Biodiversity Area Canada project experts to assess KBAs

- Integrating the data into the holdings of Canada's provincial and territorial Conservation Data Centres

Please contact the EBAR-KBA team at EBAR-KBA@natureserve.ca if you have any questions regarding data sharing or our data security policies and procedures.

Why are some ecoshapes so large?

Allowing experts adjust the line work during the expert review phase is a very time-consuming process that is not easily scaled for producing many species ranges or for updating ranges through time. Furthermore, editing the base line work renders the process of producing species ranges to be non-transparent and non-repeatable, because there are inconsistencies in how precise different expert reviewers are, and because it is difficult to standardize spatial edits. A benefit of using pre-defined line work (and retaining the line work during the expert edits) is that there is typically documentation that accompanies each jurisdictional dataset which includes a short description about each ecoshape, which can be a helpful resource for expert reviewers.

To capture more detail about a species' distribution within each ecoshape, expert reviewers can enter information into several fields in the attribute table of the species range. For example, if an expert adds an ecoshape to a species range, and that ecoshape does not contain any occurrences or observations, they should markup that ecoshape as 'Presence Expected'. When an ecoshape is assigned this code, the expert must also enter a comment to provide an explanation (e.g. "this ecoshape contains suitable habitat but no surveys have been conducted"). Comments can also be used to provide more information about the distribution of the species within an ecoshape (e.g. "species x only occurs in low elevations in this ecoshape").

When thinking about the methods, it is also helpful to keep the definition, or purpose, of the range data in mind, which is to represent the geographic extent where a species may occur. Range data are coarse scale and should not be used for all types of applications and analyses and will represent the distribution of some species better than others. The long-term goal is to offer our clients a suite of spatial products, so that clients can pick and choose information that works best for them depending on the intended uses, and life history of the species in question. Many programs in the network currently release Element Occurrence data, and we plan to produce Habitat Suitability Models (HSMs) after the EBAR project protocols and tools are fully implemented. The species range data and HSMs will have some similarities and differences. The HSMs will be based on similar observation/occurrence data, but will incorporate environmental predictors (e.g. elevation, soil types, etc.), and will use the species ranges as the bounding extents for the model outputs. The methods to produce the HSMs will be more complex to produce (e.g. Random Forests, MaxEnt) and thus are also more complex for clients to interpret and understand the limitations. If species experts were allowed to edit the species range line work, then the methods would start falling into the realm of HSM modelling. For example, an expert might move the perimeter of the species range so

that it follows a river or certain elevation contour, and in this case, the experts are essentially incorporating select environmental predictors into the production of the species ranges. Because NSC will be producing HSMs in addition to species range data, it is preferable to keep the range data methods simple, transparent and repeatable, and distinct from the HSMs.

Why can't I see the species occurrences behind the ecoshapes?

EBAR maps are based on species occurrences collected through extensive data mining. The maps provide transparency to this underlying data through references. However accurate species observations are sensitive and will not be shared at this time.

What happens when reviewers have differing opinions?

The NSC EBAR team will resolve conflicting reviews by considering the evidence and, if appropriate, contacting the reviewers for clarifications.

I am interested in customizing EBAR maps (e.g. using watersheds instead of ecoshapes) for my organization or program.

We are interested in working with partners on EBAR customization that better suit various project or information applications. Please contact us to discuss your needs. We are currently seeking funding to create ranges for additional species. We would also like to identify users who would prefer that an alternate base linework mosaic is used (e.g. marine or watershed polygons to produce ranges for aquatic species).

You can access all Python, R and JavaScript code used to develop EBAR and the EBAR Reviewer on GitHub (https://github.com/NatureServe-Canada).

Appendix 1

Jurisdiction	Source	Classification Level	Citation
Continental US	EPA	Ecoregion Level IV	Level III and IV Ecoregions of the Continental United States, 2013. United States Environmental Protection Agency. Accessed August 2019 at https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states.
Alaska	USGS	Ecoregion	Nowacki, Gregory; Spencer, Page; Fleming, Michael; Brock, Terry; and Jorgenson, Torre. Ecoregions of Alaska: 2001. U.S. Geological Survey Open-File Report 02-297 (map)j. Accessed October 2019 at https://www.usgs.gov/centers/asc/science/alaska-ecoregions-mapping
Mexico	Conabio	Ecoregion Level IV	Ecorregiones terrestres de México, 2008. Instituto Nacional de Estadística, Geografía e Informática (INEGI), México. Accessed August 2019 at http://www.conabio.gob.mx/informacion/gis/.
PEI	National Ecological Framework for Canada	Ecodistrict	A National Ecological Framework for Canada, 1995. Ecological Stratification Working Group. Agriculture and Agri-Food Canada and Environment Canada, Ottawa/Hull. Accessed February 2019 at https://open.canada.ca/data/en/dataset/3ef8e8a9-8d05-4fea-a8bf-7f5023d2b6e1.
Newfoundland	NL Natural Areas Division	Subecoregion	An Ecological Subdivision of the Island of Newfoundland, 1983. By A. W. H. Daaman. In G. R. South (Ed.), Biogeography and Ecology of the Island of Newfoundland. Junk Publishers, The Hague.
Labrador	Nature Conservancy of Canada / NL Natural Areas Division	Ecodistrict	Labrador Nature Atlas, Volume II: Ecozones, Ecoregions and Ecodistricts, 2013. By John L. Riley, Lindsay Notzl and Randal Greene. Nature Conservancy of Canada, Toronto, with support of the Government of Newfoundland and Labrador and the Labrador Conservation Blueprint Core Team. http://support.natureconservancy.ca/pdf/blueprints/Labrador-Nature-Atlas-Vol2.pdf.
Nova Scotia	Ecological Land Classification	Ecodistrict	Ecological Land Classification for Nova Scotia, 2017. By Peter Neily, Sean Basuill, Eugene Quigley and Kevin Keys. Department of Natural Resources, Government of Nova Scotia. Accessed February 2019 at https://novascotia.ca/natr/forestry/ecological/ecolandclass.asp.
New Brunswick	NB DNR	Ecodistrict	Our Landscape Heritage: The Story of Ecological Land Classification in New Brunswick, Second Edition, 2007. Vincent F. Zelazny (Ed.), Department of Natural Resources, Government of New Brunswick. Accessed February 2019 at http://www.snb.ca/geonb1/e/DC/catalogue-E.asp.

Quebec	Le Cadre écologique de référence du Québec (CERQ)	Niveau 3	Guide d'utilisation du Cadre écologique de référence du Québec (CERQ), version de diffusion 2018. Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC), Québec. Accessed February 2019 at https://www.donneesquebec.ca/recherche/fr/dataset/cadre-ecologique-de-reference.
Ontario	Ecological Land Classification	Ecodistrict	Ecological Land Classification of Ontario, 2012. Based on work by Angus Hills (1959 and later), the ELC Working Group (2000) and others. Accessed February 2019 at https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home?uuid=948bfc19-33d9-4006-abe2-64a74786bc2e.
Manitoba	National Ecological Framework for Canada	Ecodistrict	Terrestrial Ecozones, Ecoregions, and Ecodistricts of Manitoba: An Ecological Stratification of Manitoba's Natural Landscapes, 1998. By R.E. Smith, H. Veldhuis, G.F. Mills, R.G. Eilers, W.R. Fraser, and G.W. Lelyk, Research Branch Technical Bulletin 1998-9E, Agriculture and Agri-Food Canada.
Saskatchewan	Biota (MapServer)	Landscape Areas (or ecodistrict)	Saskatchewan Landscape Areas. Accessed February 2019 at https://gis.saskatchewan.ca/arcgis/rest/services/Biota/MapServer.
Alberta	Natural regions and subregions	Subregion	Natural Regions and Subregions of Alberta, 2006. Compiled by D.J. Downing and W.W. Pettapiece. Natural Regions Committee, Government of Alberta, Publication Number T/852. Accessed February 2019 at https://www.albertaparks.ca/albertaparksca/library/downloadable-data-sets/.
British Columbia	Ecoregion Ecosystem Classification of BC	Ecosection	An Introduction to the Ecoregions of British Columbia, Third Edition, 2011 . By Dennis A. Demarchi. Ecosystem Information Science, Ministry of Environment, Government of British Columbia. Accessed February 2019 at https://catalogue.data.gov.bc.ca/dataset/ecosections-ecoregion-ecosystem-classification-of-british-columbia
Yukon	Ecological and Landscape Classification of Ecoregions	Ecodistrict	Ecoregions of Yukon, 2014. Ecological and Landscape Classification of Ecoregions Technical Working Group, Government of Yukon, Whitehorse.
Northwest Territories	Ecological Areas	Level IV Ecoregions	Northwest Territories Level IV Ecoregions, 2013. Ecosystem Classification Group, Department of Environment and Natural Resources, Government of the Northwest Territories. Accessed February 2019 at http://www.geomatics.gov.nt.ca/wms_chartop.aspx?i=1.

Nunavut	National Ecological Framework for Canada	Ecodistrict	A National Ecological Framework for Canada, 1995. Ecological Stratification Working Group. Agriculture and Agri-Food Canada and Environment Canada, Ottawa/Hull. Accessed February 2019 at https://open.canada.ca/data/en/dataset/3ef8e8a9-8d05-4fea-a8bf-7f5023d2b6e1.