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

Version Date: April 2023

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1.0 Background

NatureServe Canada's Ecosystem-based Automated Range (EBAR) aims to produce trusted and publicly accessible range geodata and maps for species in North America.

The objectives of the project are to develop range geodata 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 ecoshapes (polygons of ecoregions, ecodistricts, or other representations of ecosystems) that were selected by North American jurisdictions as the best available ecosystem depictions for their area of responsibility at a regional scale. These ecoshapes 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 are 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 are available.
- Provide a secure, web-based means to efficiently collect expert review.
- Provide references to the underlying occurrence data.

NatureServe Canada makes species EBAR data products publicly available online at no cost. The published ranges include 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, organizations responsible for land use planning, academia, and others. Please visit our website for more information: https://www.natureserve.org/canada/ebar.

2.0 Contact

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

3.0 Acknowledgments

EBAR was developed based on the work of the Northwest Territories, British Columbia, Wyoming and Oregon NatureServe Conservation Data Centres/Member Programs.

We would like to thank the NatureServe Map of Biodiversity Importance (MoBI) project for sharing their knowledge, expertise, and code with us. Their help made the EBAR Reviewer app a success.

EBAR would not have been possible without the generous financial support of Environment and Climate Change Canada and the Royal Bank of Canada Tech for Nature Fund, and the generous in-kind support of NatureServe Network Conservation Data Centres/Member Programs, provincial/territorial/federal governments, and independent species experts.

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

Finally, we thank the species experts who are generously offering their time and expertise to review and refine the EBAR auto-generated ranges.

4.0 Citation

EBAR species ranges are free of charge and released under CC by 4.0 (https://creativecommons.org/licenses/by/4.0/). If you would like to use EBAR maps in a project or products, please use the following citation:

Multiple species:
NatureServe Canada. 2023. Ecosystem-based Automated Range (EBAR). Ottawa, Canada. Retrieved on [insert date] from [insert url]

Single species:
NatureServe Canada. 2023. Ecosystem-based Automated Range (EBAR) for [insert species name, version, stage, and scope]. Ottawa, Canada. Retrieved on [insert date] from [insert url]

5.0 Overview

The steps used to develop EBAR geodata 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 merge of ecoregions, ecodistricts, and 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 NatureServe Conservation Data Centres and Member Programs, provincial, territorial and federal governments, citizen science platforms, digital biodiversity data resources, 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 older than 40 years it was given a historical presence value.

4. EBAR Reviewer: a secure online app that allows species experts to efficiently review and refine 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. Review comments are documented for future reference.

6. Publish: ranges rated as high quality by our expert reviewers are published and made available at no charge on our public facing project webpage (https://www.natureserve.org/canada/ebar) and other popular sites.

7. Continual Improvement: as new data or expertise is available the range maps can easily be re-generated and new versions released.
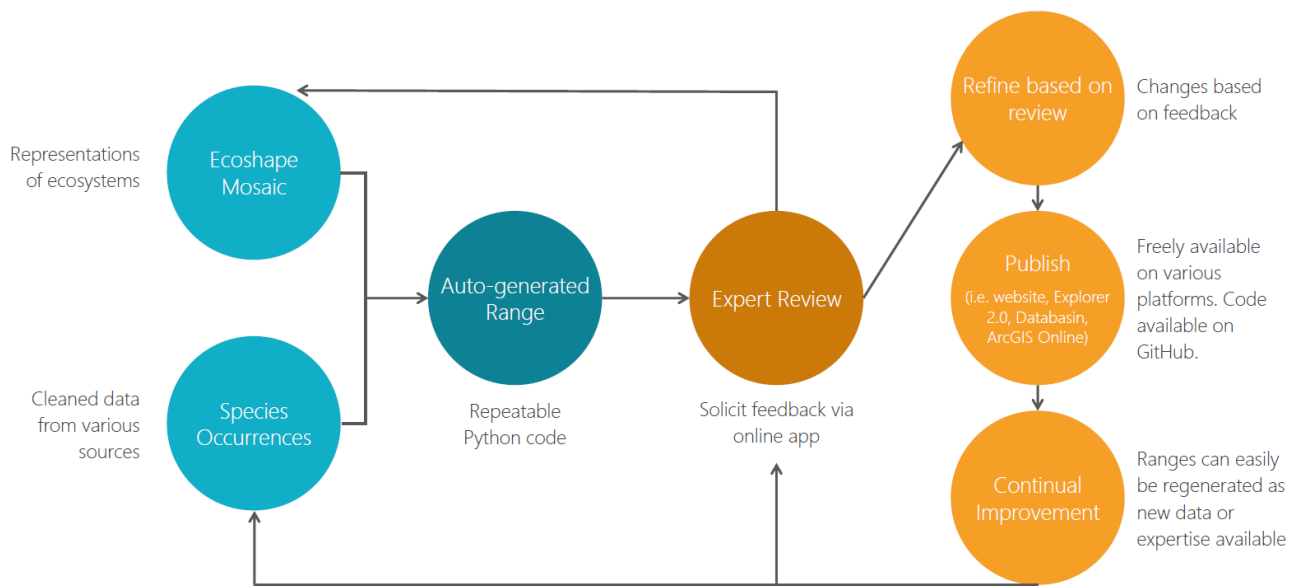
Figure 1: Overview of the EBAR map production process.

6.0 Ecoshapes

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

The EBAR team (Appendix 1) contacted 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, ecological 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 2.

The EBAR team did not contact Member Programs in the United States or Mexico, however, we 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 2.

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 merged. To request detailed methods on how this alignment was done please email the EBAR team (EBAR-KBA@natureserve.ca).

7.0 Species Selection

In 2019, the focus of NatureServe Canada's EBAR mapping work was priority species for the Canadian Key Biodiversity Areas (KBA) project (i.e., Global and National KBA trigger species). Mapping work for additional priority species is underway (see below).

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.

In 2021, the EBAR mapping work expanded to priority species for Environment and Climate Change Canada (e.g., COSEWIC to be assessed/re-assessed, SARA-listed species). The expansion of this work included the enhancement of EBAR data model and methods for migratory and wide-ranging species (see section 11.1 below).

8.0 Data Mining

The EBAR program uses auto-generated code scripts to allow for efficient updates using the best available data. Species occurrence data are mined from the Conservation Data Centres, provincial, territorial and federal governments, citizen science platforms, digital biodiversity data resources, academia, non-governmental organizations, industry, and species experts.

R packages ('spocc', 'rbison, 'rgbif') were utilized to download data from digital biodiversity data resources (GBIF, iNaturalist.org, BISON, iDigBio, ecoengine, and

VertNet). The eBird basic dataset (EBD) was requested for the EBAR-KBA project via the eBird data request portal. The R package 'auk' was utilized to extract data from the EBD. R code used for data mining can be found at https://github.com/NatureServe-Canada/SpeciesDownload.

Breeding Bird Atlas data was acquired through the NatureCounts website at https://naturecounts.ca/nc/default/main.jsp.

A list of the sources used to generate each range is automatically loaded in the metadata for each species range. All Python and JavaScript codes developed for the EBAR program are available on Github. The EBAR program allows for continual refinement of species ranges as new input data and ecoshapes are identified and made available. Please email the EBAR team for any questions, data sharing, reviewing or comments, collaborations are very welcome (EBAR-KBA@natureserve.ca). A list of the species for which we are seeking data and expert review is maintained on the NatureServe Canada EBAR webpage.

9.0 Input data

For EBAR maps, there are data attributes which must be recorded for spatial input data. These attributes help describe the taxon's distribution.

Table 1: Attributes for polygons/lines and points (✓ indicates whether the field applies to polygons/lines and/or points). Additional attributes for element occurrence and source feature data are also used. Please reach out to EBAR-KBA@natureserve.ca for more information.

Field	Description	Notes	Polygons/Lines	Points
UniqueID	Data provider's unique identifier	This is kept to manage duplicate points in database and to assist with data refreshes	✓	✓
ScientificName	Scientific name of the taxon	Based on NatureServe's Canadian scientific name	✓	✓
MaxDate	Maximum date that the species was observed	If no date listed, will refer to MinDate	✓	✓
Geometry	Latitude and longitude in decimal degrees, or spatial geometry for polygons		✓	✓
Accuracy	Spatial uncertainty in metres	If not provided, default is 10 m		✓
BreedingAndBehaviourCode	BreedingAndBehaviourCode of the species in that area (required if applicable)	Codes based off eBird breeding and behaviour codes		✓

MinDate (Optional)	Minimum date that the species was observed	Optional if MaxDate is given	✓	✓
RepAccuracy	Indicates the level of accuracy associated with the Element Occurrence (EO)		✓	
EOData	For species Elements, data collected on the biology of this Element Occurrence (EO), including the number of individuals, vigor, habitat, soils, associated species, peculiar characteristics, etc.		✓	
Other EO fields…	Etc.	Etc.		

10.0 Geodatabase 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 data they require for their EBAR-KBA work and must meet all the relevant data security requirements before they can access the data.

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 cut-off was selected since it is the largest possible iNaturalist obscured coordinate distance (which is 0.2 x 0.2 degrees); however, this cut-off 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 only those 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.

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

11.0 Auto-generation

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

Species occurrence data are buffered by the uncertainty distance given by the data provider. If no uncertainty distance or an uncertainty distance of 0 was reported points were buffered by 10 metres. Lines were buffered by 10 metres regardless of the reported uncertainty distance. This was done to allow the polygon-based algorithm to process all data types.

Ecoshapes are populated with one of the following presence values:

1) Present: the species is found within the ecoshape based on species observation data, NatureServe Element Occurrence and Source Feature data, Canadian federal Critical Habitat delineations, or expert opinion

2) Presence Expected: The species is not deemed to be "Present" based on the definition above, but the habitat is suitable for the species according to expert opinion, a range estimate, or a habitat suitability model

3) Historical: all species occurrence data within the ecoshape has an observation date older than 40 years 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		<=40 years old	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
Range		>40 years old	Historical

Ranges are produced at various geographic scales (national, global, or North American), as 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 for each range is defined as they 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 through spatial constraints (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 found in the metadata for each species range.

11.1 Auto-generation- Migratory and wide-ranging species

The EBAR data model was enhanced to allow the development of EBAR ranges for migratory and wide-ranging species, including but not limited to caribou, birds, and

monarch butterfly. To account for seasonal differences in these species' ranges, we incorporated an additional layer of data pertaining to breeding information. In addition to the three presence classes included in the original EBAR data model, the migratory model includes two usage type classes: Breeding and Possible Breeding. All other areas not marked with breeding information are considered "non-breeding", "migration", and/or "unknown".

Ecoshapes are populated with one of the following breeding values:

1) Breeding - the species is thought to breed within the ecoshape based on eBird Breeding and Behaviour Codes or expert opinion.
2) Possible Breeding - the species is probably or possibly breeding within the ecoshape based on eBird, BBA or jurisdiction Breeding and Behaviour Codes, or on expert opinion.

12.0 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 for expert reviewers. In brief, experts were assigned species and provided a unique login to the EBAR Reviewer app. Once logged in to the 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 presence 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. a low rating based on missing data, or the range 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.
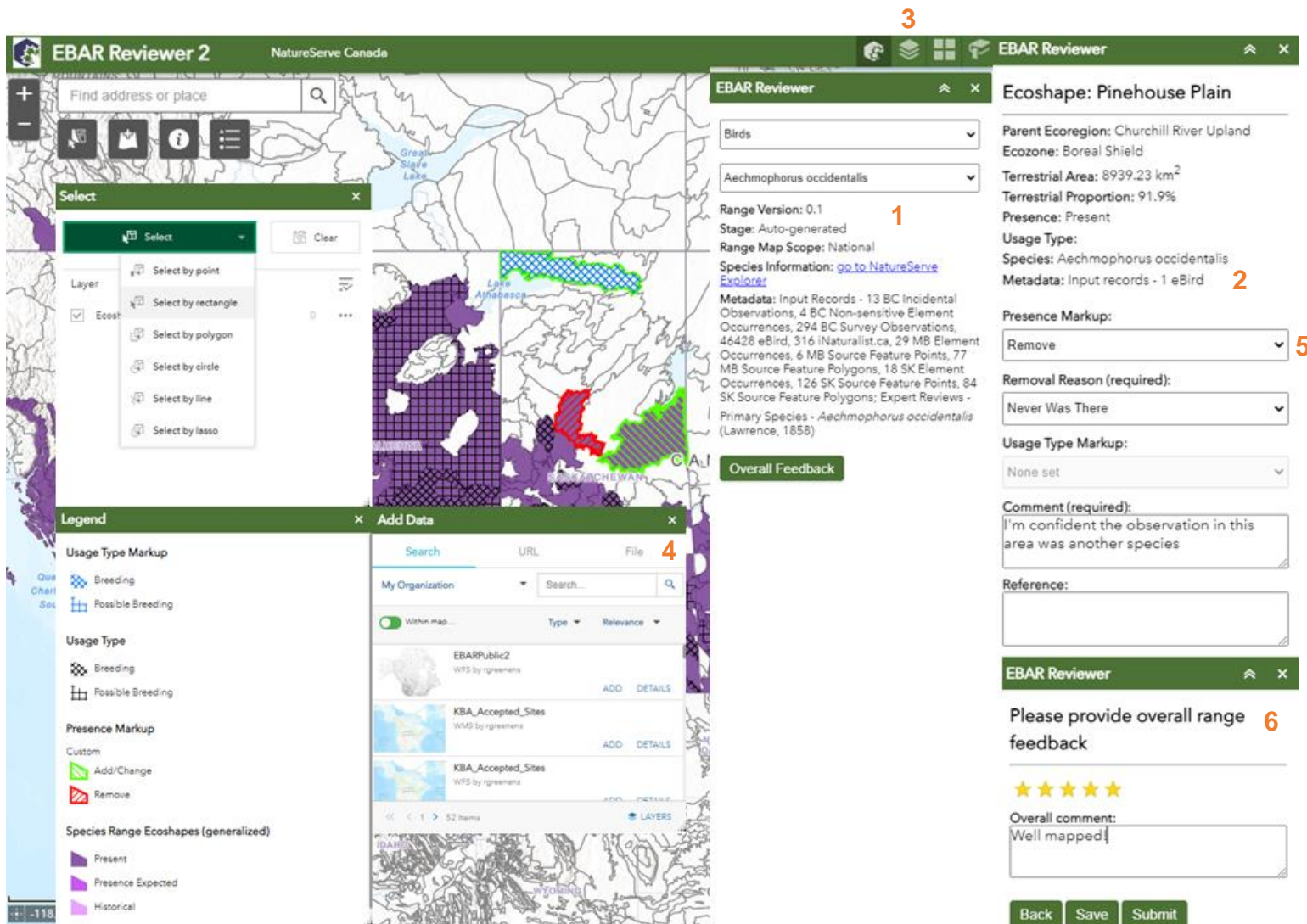
Figure 2: Screen shots from EBAR Reviewer 2.0 application showing main features that allow for expert review: 1) select species and view the range metadata, 2) select an ecoshape and view the species/ecoshape metadata, 3) optionally view non-restricted input data, 4) temporarily view personal data (reviewer can temporarily upload their personal data to the reviewer app) 5) markup ecoshapes by suggesting they be added or removed from the species range, or have their presence value changes, and 6) provide overall feedback on the species range.

13.0 Publication

EBAR species ranges are made available at no cost. Currently EBAR species ranges are available for download through the EBAR project website, through NatureServe Explorer 2.0 (under the Distribution section), our Esri online app and the Esri Living Atlas. EBAR species ranges are available in PDF format and as a geospatial data package with associated metadata.

Table 2: Metadata included in published range maps.

Metadata in published EBAR maps	Description
Species name	Scientific name of species
Range Version	Label to indicate the EBAR version (e.g., 1.0)
Range Stage	Label for stage/phase within version (e.g., Auto-generated, Expert Reviewed)
Range Date	Date the EBAR map was generated
Range Metadata	Summary of the Input records and Reviews that contributed to the EBAR
Range Map Notes	Names, with name references/citations, of the primary Species and (optional) SecondarySpecies and Synonyms used
Range Map Scope	Scope of the EBAR (e.g., Global, North America, or Canadian)
Range Map Comments	Other comments to be included in published EBAR
Synonyms Used	Names, without name references/citations, of the SecondarySpecies and Synonyms used
Map projection	North America Albers Equal Area Conic (WKID 4269)
Suggested Citation	Information about how to cite EBAR
License	Information on the licensing of the EBAR products
Project Website	Link to project website
Contact	Email address of who to contact about EBAR
Input References	List of data sources that were used to develop the specific EBAR map
Reviewers by Taxa	Link to the full list of reviewers who contributed to the expert review of EBAR maps

We will release species ranges in batches as they are finalized. Please check the EBAR project 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.

14.0 Funding to produce EBAR ranges for additional species

We are currently seeking funding to create ranges for priority species not covered by our KBA and ECCC Priority Species project funding and to complete the refinement of

EBAR ranges that have not yet been published due to the need for additional data mining and/or expert review.

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 contact the NatureServe Canada EBAR team if you would like to discuss project partnerships and funding opportunities (EBAR-KBA@natureserve.ca).

15.0 Frequently Asked Questions

15.1 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
- The Key Biodiversity Area Canada project (to support analyses by experts to delineate KBAs)
- Developing Suitable Habitat Models
- Integrating into the data holdings of Canada's provincial and territorial Conservation Data Centres
- Integrating the data into the public facing NatureServe Explorer Pro platform (at a data precision that you approve)

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

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

EBAR maps are based on species occurrences collected through extensive data mining. EBAR maps provide transparency to this underlying data through references. Users have access to our R code to obtain updated species data from all open sources used in EBAR. However, some species input data are restricted by the data provider (e.g., species that are subject to persecution and harm from poaching) and cannot be displayed in EBAR maps and products based on the permissions documented by the original data provider.

15.3 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.

15.4 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 suits 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 like to use an alternate base linework mosaic (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: List of EBAR Team Members (March 21, 2023)

- Samantha Stefanoff, EBAR National Coordinator, NatureServe Canada
- Randal Greene, EBAR Technical Coordinator, NatureServe Canada
- Katrina Gaibisels, EBAR Data Technician, NatureServe Canada
- Jacqueline Clare, Data and Information Management Unit Lead, BC Conservation Data Centre, Ministry of Environment and Climate Change Strategy, Government of British Columbia
- Suzanne Carrière, Wildlife Biologist (Biodiversity), Northwest Territories Conservation Data Centre, Government of Northwest Territories
- Amie Enns, National Data Manager, NatureServe Canada
- Patrick Henry, Executive Director, NatureServe Canada
- Bonnie Fournier, EBAR Volunteer

Appendix 2: List of Ecoshape Sources

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. |