Environment and Climate Change Canada | Environnement et Changement climatique Canada

Canada

January 14, 2026

Regional Assessment in the Ring of Fire Area
Impact Assessment Agency of Canada
RegionalROF-CDFRegionale@IAAC-AEIC.gc.ca

Re: Requests to Federal Agencies and Departments for the Regional Assessment in the Ring of Fire Area from the Regional Assessment Working Group

Dear Isabelle Turcotte,

Thank you for your email of September 25, 2025, containing general and targeted requests to Environment and Climate Change Canada. Please find attached the information requested including our responses.

We look forward to continuing to work with the Regional Assessment Working Group and participating in this collaborative effort.

If you have any questions or require further information, please contact Megan Young by email at Megan.Young@ec.gc.ca.

Sincerely,

<Original signed by>

Robert Clavering
(il/lui/he/him)
Acting Regional Director
Environmental Protection Branch, Ontario Region

CC:
Robert Read, Environmental Protection Branch, Ontario Region
Megan Young, Environmental Protection Branch, Ontario Region

ECCC Response: "Requests to Federal Agencies and Departments for the Regional Assessment in the Ring of Fire Area from the Regional Assessment Working Group – Package 1"

#	*Targeted recipient(s)*	*Topic*	*Request*	*ECCC Response*
1	All	**Projects and Initiatives relevant for the Ring of Fire Area**	a) Provide a list of the projects and initiatives in which you are involved in that relate to the Ring of Fire Assessment Area. For each item, include: i. Project name, description and timeframe ii. Lead organization iii. Other collaborators iv. Your role v. Geographic location (include maps if available) b) Explain if and how Indigenous Nations and communities in the Ring of Fire Area collaborated in these projects and initiatives. Would you be willing to give a public presentation about any of these initiatives to the working group, and if so which ones?	Please see Attachment I: "*ECCC Projects and Initiatives relevant for the Ring of Fire Regional Assessment*". Please note that this does not include projects where ECCC's role is solely or mostly providing funding (i.e., through ECCC contribution agreements). For those projects, please see the March 2025 ECCC FAAR Response – Wildlife related funding (pages 28 – 31).
2	All	**Priority topics identified by the Working Group – Information and Gaps**	In the Call for Information and Data, the Working Group identified **key priorities** for information gathering and gap identification at this time. Table 3 reflects these key priorities.	Please see Attachment II: "Priority Topics – Information and Gaps". Furthermore, a table of ECCC Datasets Within Assessment Area was provided as part of the March 2025 ECCC FAAR Response – Wildlife Datasets Within Assessment Area (pages 32-37). There are no new datasets to add since that time, but the table has been updated to include an additional column indicating means to access each dataset (Attachment IV).

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			Referring to the priorities and issues listed in Table 3, based on your expertise, provide advice on: a) the best sources of existing data, including means to access it, b) adequate spatial and temporal boundaries to assess impacts, c) key indicators to describe potential impacts, d) known data gaps or uncertainties, and e) suggestions for studies or other ways to fill those gaps.	
3	ECCC, ISED, and NRCan	**Critical Minerals Strategy – Economics and Valuation**	The Working Group requires information to better understand how industry and governments estimate potential benefits from critical mineral development. a) Describe and explain the choice of methods used in federal reporting to estimate economic benefits related to mining critical minerals in the Ring of Fire Area. b) Share any information you have about how financial revenues from mining in the Ring of Fire might flow to various parties, such as who would benefit at local, regional, national, and	ECCC does not have responses for these questions specific to the Ring of Fire area at this time.

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			international scales. In addition, or if this information is not available, please recommend: i. existing case studies that could be used as examples, and ii. sources of expertise within or outside government that could be approached by the Working Group to provide this information. c) Explain if and how the federal government has conducted studies to value potentially impacted ecosystem goods and services in comparison to projected revenues from critical minerals mining.	
4	DFO, ECCC, Transport Canada, and NRCan	**River systems – Scale of studies, existing information and gaps**	The Working Group is interested in baseline studies and analyses of potential impacts at a river-system scale related to geochemistry, hydrogeology, hydrology, water quality and quantify, fish and aquatic wildlife, and navigability. a) Identify existing studies at the spatial scale of the major river systems in the Ring of Fire Assessment Area, i.e.: Abitibi	a) Identify existing studies at the spatial scale of the major river systems in the Ring of Fire Assessment Area, i.e.: Abitibi River, Attawapiskat River, Ekwan River, Kenogami River, Mattagami River, Missinabi River, Moose River, the Lower and Upper Albany Rivers, and the Winisk River. As mentioned in Attachment II (response to 2a), water quality and hydrological data, including for these river-systems, may be reported as part of federal or provincial authorizations or permits. For example, the Victor Diamond Mine Project may have analyses of potential impacts to the Attawapiskat River and other rivers in the area. ECCC is otherwise not aware of baseline studies at an individual river-system scale related to hydrology within the RoF assessment area. It is worth noting two articles that explore flow variations and trends for the periods of 1960-2016 and 1964-2013 in some of the river systems in the area that may be of interest to the Regional Assessment Working Group (RAWG):

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			River, Attawapiskat River, Ekwan River, Kenogami River, Mattagami River, Missinabi River, Moose River, the Lower and Upper Albany Rivers, and the Winisk River. b) If this information does not exist, advise on how it would be possible to obtain portraits of these river systems, including if there are plans underway to conduct these studies. c) Based on your experience in project-level impact assessments, advise whether there are standard mitigation measures that may be applicable to protect the water systems in the Ring of Fire assessment area from potential impacts for development activities in general. d) Include a discussion of the key sources of uncertainty unique to this assessment area related to the effectiveness of these measures, and what your role might be in reducing these uncertainties.	• Flow alteration impacts on Hudson Bay River discharge (https://doi.org/10.1002/hyp.13285). This study explores flow regulation controls on daily river discharge variations and trends into Hudson Bay from four highly regulated and 17 moderately regulated/unregulated systems over 1960–2016; and • Recent trends and variability in river discharge across northern Canada (https://doi.org/10.5194/hess-20-4801-2016). This study presents an analysis of the observed inter-annual variability and inter-decadal trends in river discharge across northern Canada for 1964–2013. b) <u>If this information does not exist, advise on how it would be possible to obtain portraits of these river systems, including if there are plans underway to conduct these studies.</u> These major river systems in the RoF area could be better understood through the development of a regional hydrological assessment including hydrologic models developed under an integrated framework. Cumulative impacts with respect to surface water quantity based on existing and planned development could be quantified, at the river-system, by these types of studies. Hydrologic models are mathematical representations of the hydrological cycle and require extensive data to construct and to validate, however they are still susceptible to uncertainty in the predictions. ECCC notes that impacts to water quantity are not under federal jurisdiction but are the basis for evaluation of impacts to other valued components such as water quality, and fish and aquatic wildlife. For water quality, a water quality baseline study, such as those suggested for the Marten Falls Community Access Road, Northern Road Link, and Webequie Supply Road Projects, could be conducted to address baseline water quality gaps for these river systems. Other data gaps and suggested studies are listed in Attachment II (2d and 2e). c) <u>Based on your experience in project-level impact assessments, advise whether there are standard mitigation measures that may be applicable to protect the water systems in the Ring of Fire assessment area from potential impacts for development activities in general.</u> **Water quality** Standard mitigation measures, such as erosion and sediment control measures, may be used during construction and decommissioning to protect the water systems in the RoF assessment area. Examples of erosion and sediment control/management can be found in published documents, such as those by the CSA Group (e.g., CAN/CSA-W202-

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				18 (R2023) | Codes & Standards | Product | CSA Group, CSA W208:20 | Codes & Standards | Product | CSA Group, CSA W205:19 (R2024) | Codes & Standards | Product | CSA Group). For linear infrastructure, stormwater management measures may protect the water systems in the RoF assessment area. The Ontario government has published a "Stormwater Management Planning and Design Manual (2003)" which provides technical and procedural guidance for planning, design and review of stormwater management practices (https://www.ontario.ca/document/stormwater-management-planning-and-design-manual-0). For metal mining, ECCC has developed "The Environmental Code of Practice for Metal Mines (2009)". The objective of the Code is to identify and promote recommended best practices in order to facilitate and encourage continual improvement in the environmental performance of mining facilities throughout the mine life cycle (https://www.canada.ca/content/dam/eccc/migration/main/lcpe-cepa/documents/codes/mm/mm-eng.pdf). **Water quantity** Given the size of the RoF area and the rich reserves of critical minerals present, it is anticipated that extensive development, including mining projects and supporting infrastructure, and expansion of communities and services will occur as the area develops. Standard mitigation measures aimed at protecting water systems would prevent or reduce impacts on changes to water quantity as a result of project activities or built infrastructure. While this is not an exhaustive list, and noting that different projects might require more specialized mitigation measures, standard mitigation measures, per project type, include the following: • For linear infrastructure: Implement stormwater management in the form of adequate design of ditches and water crossings to minimize disruption to watercourses and natural features. Consider design alternatives less disruptive to watercourses and natural features. Minimize disturbance of watercourses and natural features during construction, including minimization of changes to flow and levels as a result of in-water construction, schedule in-water work for periods of low flow, minimize vegetation clearing. Maintain protective vegetation buffer zones next to watercourses during all phases of the project. Maintain stormwater infrastructure. Consider adaptative mitigation measures monitoring to prevent impacts with respect to water quantity. • For linear infrastructure built over peatlands: Consider alternative construction methods such as floating road to prevent excavation of peatland under the road, installation of equalization culverts to maintain existing

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				hydrological connectivity upstream and downstream of the road. Consider robust adaptative mitigation measures and monitoring during all phases of the project to monitor for and prevent loss of peatland functionality with respect to loss of hydrologic connectivity. • For mining projects: Limit, to the extent possible, activities such as vegetation clearing and grubbing, regrading and recontouring, and minimizing the overall project footprint. Consider potential changes to drainage patterns and runoff coefficients during all phases of the project. Development of a water management plan which includes infrastructure to manage water on-site, plan to control discharges to the environment, and demonstrate plan viability under extreme conditions. Ensure adequate capacity of water storage facilities (tailings ponds, stormwater pond) based on the design storm and required level of treatment. Implement adaptative mitigation measures to prevent and minimize impacts to streamflow and water levels in the receiving environment associated with water takings or discharges. **Emergency Management** ECCC also suggests the following standard mitigation measures that could be applied generally to projects to help prevent and/or mitigate the impacts of spills, accidents, and malfunctions during the construction, operation, and decommissioning of development activities in the RoF assessment area. • Studies and information gathering: o Conduct pre-Shoreline Cleanup Assessment Technique (pre-SCAT) studies to document baseline conditions in the region, which can inform on environmental sensitivities and cleanup targets in the event that a spill occurs. o Conduct spill modelling to determine what areas would likely be impacted by spills, and the extent of the impacts. o Conduct a risk assessment of plausible accident and malfunction scenarios (including risks originating from natural hazards of environmental conditions at proposed project locations) that could result from proposed development activities. A comprehensive risk assessment will include the following components: o A description of plausible accident and malfunction scenarios; o A risk assessment of these scenarios, including an evaluation of their likelihood and potential impacts;

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				- A description of worst-case accident and malfunction scenarios, as well as alternate worst-case scenarios that could reasonably be expected to occur as a result of project activities. An alternate worst-case scenario is defined as one that is more likely to occur that the absolute worst case, and which would result in long-lasting impacts;
				- A description of the proposed mitigation measures to minimize the effects of each scenario, including relevant plans or draft plans that demonstrate how these measures would be implemented if such plans are cited as mitigation; and
				- An assessment of the residual risks that remain once mitigation measures are implemented.
				• Infrastructure:
				- Use of secondary containment for fuels and other petrochemicals is recommended to follow the design and capacity guidelines established in the *Code of Practice for Storage Tank Systems Containing Petroleum and Allied Products*, section 3.9 (Secondary Containment Requirements).
				- Presence of adequately stocked spill kits and/or equipment caches at locations where hazardous substances and fuels are stored and used (including vehicles).
				• Actions:
				- Transfer of hazardous substances, including fuels, a minimum of 30 metres from the normal high water mark of any water body.
				- Carry out regular inspections and maintenance of any project equipment (including vehicles, machinery etc.) that contains or handles hazardous substances.
				- Parking vehicles and storing equipment that contains hazardous substances a minimum of 30 meters from the normal high water mark of any water body.
				- Use of a drip tray under vehicles and equipment that are idle for more than two hours.
				- Use of biodegradable hydraulic oil (when appropriate) for equipment that is working in or near water.
				- Implementation of safe fuel and hazardous chemical transfer practices, including:
				  - Nozzles equipped with automatic shutoff;
				  - Operations stationed at both ends of hoses, unless both ends of the hose are visible and accessible by one operator;
				  - Ensuring that fuel or other hazardous substances in hoses is fully discharged to the receiving equipment or back to the storage vessel; and
				  - Use of drip trays or absorbent mats when transferring fuels or hazardous substances in areas outside of secondary containment.

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				• Training: o Development of a training program for employees of plans and procedures related to environmental protection and spill response. • Plans: o Environmental protection plans to outline procedures taken to protect the environment during construction, operations and decommissioning of the project. o Spill response/emergency preparedness plans to outline procedures taken in the event of a spill or other emergency. o Hazardous waste management plan to outline how waste generated by the project will be handled. o Emergency communications plan to outline how potentially affected communities, responders, and relevant authorities will be notified of an incident. o Monitoring plans to detect and capture potential silent releases resulting from accidents or malfunctions. For example, installing monitoring wells near a tailings pond to track groundwater quality or sampling of surface water to inform its quality. • Other: o Identification of any contractor(s) (if applicable) that will be responsible for response and/or recovery following an incident. d) <u>Include a discussion of the key sources of uncertainty unique to this assessment area related to the effectiveness of these measures, and what your role might be in reducing these uncertainties.</u> Sources of uncertainty in project-related effects on river systems can vary by the type of project, but specific to the RoF area, can also be unique depending on the area where the project is located due to the presence of complex and fragile ecosystems, such as peatlands. In addition, other sources of uncertainty are highly dependent on desktop studies, shortage of publicly available information, reliance on aerial imagery, limited field data due to the remote nature of the area and expected rapid development of the area leading to a large rate of change in the natural environment. The mitigation measures identified in part c) are standard measures implemented in both linear and mining operation projects to minimize project effects in surface water quantity and quality, and although they are applicable to similar projects in the assessment area, uncertainty in the success of implementing mitigation measures can be magnified due to the reasons explained in the previous paragraph.

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				ECCC does not have a direct role to play in reducing uncertainties associated with water quantity and quality impacts, as surface and groundwater resources are an area of provincial jurisdiction. Under the *Impact Assessment Act*, ECCC reviews and evaluates the characterization of hydrology of the receiving environment and project-related impacts to water quantity and quality to determine that the data, spatial and temporal boundaries, methods and predictions are adequate to support evaluation of effects within federal jurisdiction. This includes impacts to fish and fish habitat. Moreover, ECCC can suggest to the Impact Assessment Agency of Canada (IAAC) that additional hydrometric data is collected, hydrological models in the receiving environment are re-evaluated and the findings are used to support adaptive management in the event that impacts to water quantity are different than predicted.
8	DFO and ECCC	**Species at Risk**	a) Provide summaries of knowledge on species at risk and their habitat in the assessment area, including but not limited to threats, mitigation options, and knowledge gaps. b) Comment on how Indigenous knowledge is braided in this knowledge. c) Identify any plans for conservation and protection measures focused on the species at risk in the assessment area.	Please see Attachment III: "*ECCC Response to Species at Risk*". Please also see attachment VI for a report on species at risk bats.
9	DFO, ECCC and Parks Canada	**Protected Areas**	a) Provide an overview of the various conservation and protection measures and that could contribute to protection of sensitive areas in the assessment area. Include a description of their purpose, how they complement each other, the lead organisations,	a) Provide an overview of the various conservation and protection measures and that could contribute to protection of sensitive areas in the assessment area. Include a description of their purpose, how they complement each other, the lead organisations, and current and future priorities related to the assessment area. The following are the mechanisms ECCC uses to protect sensitive areas for migratory birds and species at risk in Canada. 1) **Protected Areas**: ECCC establishes and cooperatively manages two types of protected areas: National Wildlife Areas (NWAs) and Migratory Bird Sanctuaries (MBSs).

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			and current and future priorities related to the assessment area. b) For each measure, identify how federal agencies and departments achieve conservation and protections goals in partnership with other organizations, including First Nations and environmental groups.	a. The ***Canada Wildlife Act*** **(CWA)** empowers the Minister of the Environment to acquire lands to create NWAs. The purpose of an NWA is to preserve habitats that are critical to migratory birds and other wildlife species, particularly those that are at risk. b. **The *Migratory Birds Convention Act* (MBCA)** aims to protect and conserve migratory birds as populations and individuals, their nests, and the habitat necessary for their survival. **Migratory Bird Sanctuaries (MBSs)** protect migratory birds from hunting and physical disturbance. ECCC is responsible for MBSs, although the sanctuaries can be located on federal, provincial or private land. MBS are listed under the Schedule in the *Migratory Bird Sanctuary Regulations* (MBSR), which prescribe rules and prohibitions regarding the taking, injuring, destruction or molestation of migratory birds or their nests or eggs in the sanctuaries. Hunting of listed species under the Act is not permitted in any Migratory Bird Sanctuary. An individual exercising a right recognized and affirmed by section 35 of the *Constitution Act, 1982* to hunt migratory birds and harvest their eggs may exercise those rights in MBSs, however a permit may be required if the activity negatively impacts the conservation impacts of a migratory bird that is also a SARA listed species. Several MBSs in Ontario have been established in areas with multiple landowners, while only two are entirely owned and administered by ECCC. Furthermore, several MBSs in Ontario have additional designations that provide varying degrees of protections such as Important Bird Areas (IBA - https://www.ibacanada.com/iba_what.jsp?lang=en) and Ramsar Sites (https://www.ramsar.org/country-profile/canada). There are 2 MBSs within the assessment area: Hannah Bay MBS and Moose River MBS. The priority of these two MBSs' is to protect large concentrations of migrating geese and other waterfowl from local hunting pressures during critical periods of their life cycle. Hannah Bay and Moose River MBSs are also designated IBAs of Global significance and are internationally recognized Ramsar Sites. At this time there are no future NWA or MBS priorities related to the assessment area. 2) **Other Effective Area-based Conservation Measures (OECM)** are a geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in-situ conservation of biodiversity, with associated ecosystem functions and services and

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				where applicable, cultural, spiritual, socio-economic, and other locally relevant values. OECMs can be located on federal, provincial or private land. There are specific criteria that need to be met in order for an area to be recognized as an OECM (https://www.canada.ca/en/environment-climate-change/services/nature-legacy/other-effective-area-based-measures.html). Examples of OECMs can include watershed protection zones, conservation set asides in managed forests, and certain land use planning zones. There are no current OECMs or known OECM priorities related to the assessment area. b) For each measure, identify how federal agencies and departments achieve conservation and protections goals in partnership with other organizations, including First Nations and environmental groups. For the two MBSs, ECCC collaborates with Ontario and Nunavut. Depending on the type of activity, the Minister of the Environment may authorize a prohibited activity under the MBSR through issuing a permit. Permits authorized by other federal or provincial jurisdictions may be required for additional activities within the MBS. ECCC Wildlife Officers, Royal Canadian Mounted Police (RCMP) and Ontario Conservation Officers (NDMNRF) have the authorization to enforce the MBSR. ECCC continues to promote OECMs by working with partners who are interested in recognizing an OECM, helping them evaluate their sites and understand any changes that may need to occur in order for it to meet OECM criteria, so it can be recognized and reported. ECCC’s Indigenous Led Area-based Conservation (ILABC) is an ECCC funding program that sunsets March 31, 2026. The program supported Indigenous People to lead or co-lead the establishment and recognition of protected areas or other effective area-based conservation mechanisms (OECMs) across Canada, as well as build capacity in conservation and plan for future conservation. The ILABC program was promoted publicly to eligible Indigenous groups who, through an expression of interest, identified conservation and protection goals that could contribute to Canada’s 25 by 25 and 30 by 30 goals (https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/conserved-areas.html). Applicants had to have the support of the relevant provincial or territorial government, and others with interest in the land when proposing projects on provincial or territorial lands. ILABC did not have the authority to provide funding for items outside a protected area or OECM. ECCC does not designate Indigenous Protected and Conserved Areas (IPCA). ECCC does not determine what is, or is not, an IPCA, and recognizes that Indigenous Nations, governments, and communities are best positioned to determine if their protected area or OECM is also an IPCA. ECCC has provided support to a few First Nations in the assessment area to build capacity and plan for future conservation goals, specific to these projects were assessments of intersecting interests in the land.

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11	ECCC	**Bird Conservation Strategy**	a) Please summarize the key findings from the Bird Conservation Strategies that overlap with the assessment area as they related to recommended conservation and protection measures. b) Describe how various parties have a role in the implementations of the conservation strategies, with a focus on the assessment area.	a) Please summarize the key findings from the Bird Conservation Strategies that overlap with the assessment area as they related to recommended conservation and protection measures. The Bird Conservation Strategies for the Ontario portions of Bird Conservation Regions (BCR) 7 (Taiga Shield and Hudson Plains) and 8 (Boreal Softwood Shield) were published in 2013 and 2014, respectively, and reflect information available up to that time. BCR 7 and 8 extend beyond the boundary of the assessment area and, as such, not all information and recommendations may be applicable to the Ring of Fire Assessment Area. The strategies for BCR 7 and 8 include executive summaries that summarize key findings. Recommended actions in these strategies are dominated by a need for gathering additional information, due to an incomplete understanding of the status of bird populations at the time of publication. Some of these information gaps still exist. New information is available since the publication of the strategies, including information provided by ECCC elsewhere in this response (including in Attachment II and Attachment III). Since the original BCR Strategies were published, Bird Conservation Regions (BCRs) 7 and 8 have been split in half to better reflect regional habitat differences among some of the larger northern BCRs (Figure 1). This update results in changes in the BCRs overlapping the assessment area (though not the development area). There are now 3 BCRs in the assessment area: 7H (Taiga Shield East), 8W (Boreal Softwood Shield West), and a small portion of 8E (Boreal Softwood Shield East).

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				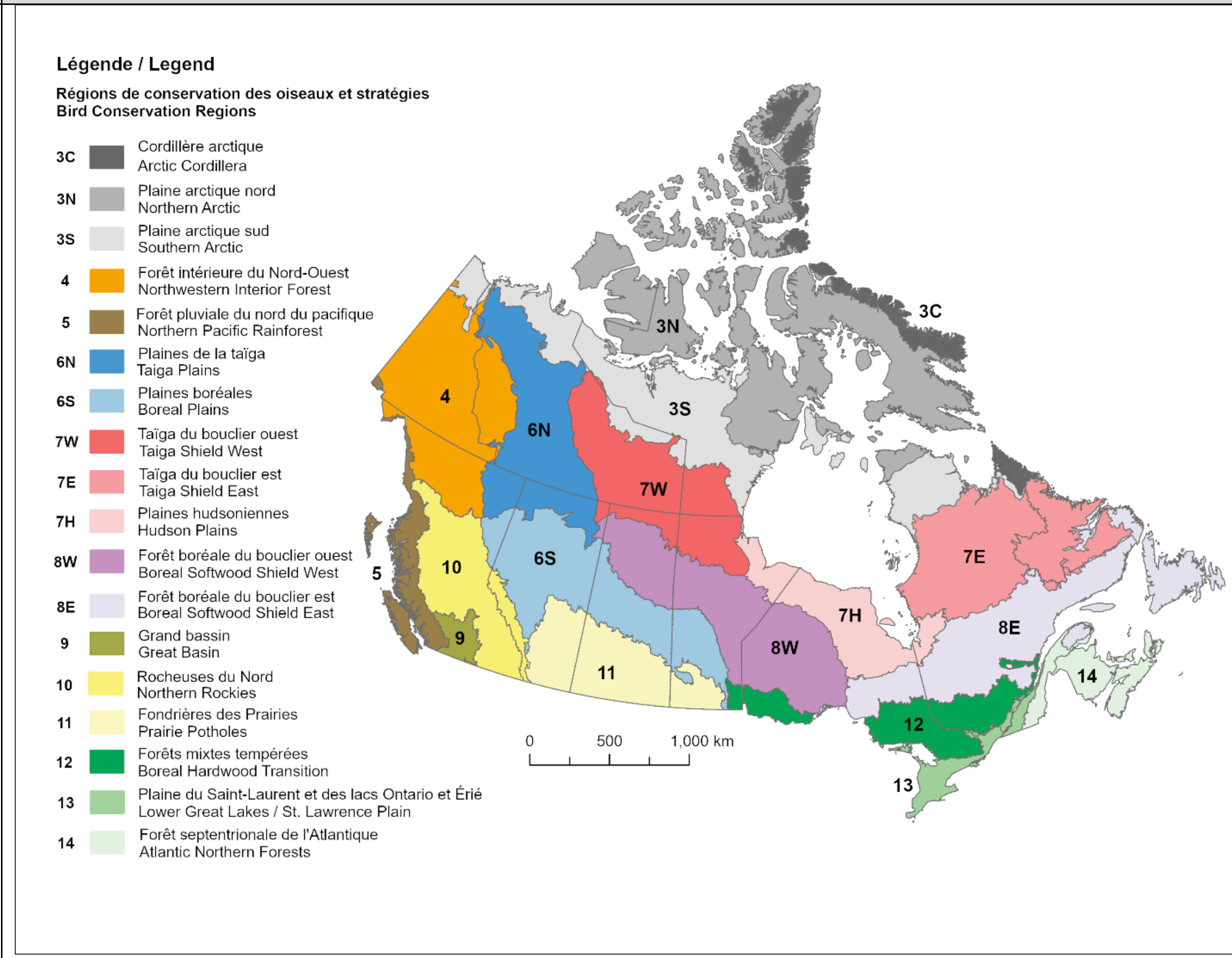 *Figure 1. Revised Bird Conservation Regions*

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				b) Describe how various parties have a role in the implementations of the conservation strategies, with a focus on the assessment area. Bird Conservation Strategies are not intended to be prescriptive, but rather are intended to guide future implementation efforts undertaken by various partners and stakeholders. ECCC is working to develop and publish BCR-based priority bird lists later this year as a mechanism to help achieve the national population goals published via The State of Canada's Birds. Links: Bird Conservation Strategy for region 7 in Ontario - https://publications.gc.ca/collections/collection_2014/ec/CW66-318-1-2012-eng.pdf Bird conservation strategy for Region 8: Ontario boreal softwood shield - https://publications.gc.ca/collections/collection_2014/ec/CW66-318-2-2014-eng.pdf
12	ISC, ISC-FNIHB, CIRNA, ECCC, DFO	**Treaty Rights and Wildlife Management**	a) Explain whether and how you obtain information about non-Indigenous land users on traditional territories for hunting, fishing, and harvesting purposes without consent. b) Explain whether and how this information factors into federal responsibilities related to: i. protection of wildlife and their habitat; and ii. documenting and any action relate to protection of Aboriginal and Treaty Rights.	(a) ECCC has interpreted this question as asking whether the department collects information to determine if individual(s) or collective non-Indigenous land users have obtained the consent of Indigenous Nations before engaging in hunting, fishing, or harvesting in their traditional territories. ECCC does not obtain information regarding the consent of Indigenous Nations in relation to non-Indigenous land-use activities. The province of Ontario is responsible for hunting and fishing regulations on non-federal lands, which encompass most traditional territories in Ontario. Concerns about harvesting migratory birds or federal species at-risk are complainant driven and can be made to ECCC at 1-800-668-6767 or by email at enviroinfo@ec.gc.ca. (b) ECCC does not obtain information regarding the consent of Indigenous Nations in relation to non-Indigenous land-use activities.

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13	ECCC and NRCan	**Cumulative Effects Assessments**	a) Identify programs and initiatives related to describing or quantifying cumulative effects within the assessment area. b) For each, summarize the focus of the assessment, the approach used to assess cumulative effects, key assumptions and limitations, and any key findings to date as well as future plans to continue or conduct new studies.	ECCC is involved in projects quantifying and analyzing cumulative effects (as identified in Attachment I) but is not performing the cumulative effects assessments or the cumulative effects modelling side of the project. As such, ECCC cannot supply additional information to answer the specifics of each assessment/model (approach, key assumptions, limitations). However, ECCC was involved in a project (#4 in Attachment I) that assessed the usefulness of various cumulative effects models. That work is detailed in Attachment V, the Cumulative Effects chapter from Canadian Wildlife Service (CWS)-ON Interim Report on Biodiversity in the Ring of Fire Region v3, which provides a current (as of summer 2025) overview of relevant work.
19	ECCC, ISED, NRCan, and Transport Canada	**Feasibility of development in this area**	Based on the sensitivity of peatlands in the assessment area and their role in global carbon sequestration, as well as the challenges related to building infrastructure on peatlands, the Working Group requests that you: a) Provide a summary of the state of knowledge regarding the sustainability of building on peatlands. b) Advise on the worst-case scenarios that have been explored for impacts of future development on the ecosystems of the Hudson Bay Lowlands, including but not limited to impacts on carbon storage.	a) <u>Provide a summary of the state of knowledge regarding the sustainability of building on peatlands.</u> **Hydrology** Building on peatlands has the potential to disrupt surface and subsurface water flows and the water table due to alteration of natural features and land uses, peat compression, water usage and redistribution of drainage from development. The hydrological disruption of peatlands can alter the hydroperiod creating flooded or dry conditions. Conditions that are too wet or too dry can inhibit wetland function (reduced flood storage, loss of biodiversity habitat and wetland vegetation). The sustainability of building on peatlands relies in continuous and long-term monitoring to capture temporal and spatial changes at the basin scale, and innovative and adaptive management and rehabilitation strategies driven by emerging monitoring methods (Monteverde et al., 2022). While rehabilitation of peatlands based on restoration of hydrological processes has been studied for specific types of peatlands, additional studies may be required to demonstrate the suitability of the rehabilitation methods to peatlands like those found in the RoF area. Reference: Monteverde, S., Healy, M.G., O'Leary, D., Daly, E., Callery, O. 2022. Management and rehabilitation of peatlands: The role of water chemistry, hydrology, policy, and emerging monitoring methods to ensure informed decision making. Ecological Informatics, Volume 69.

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			c) Explain how sensitive the ecosystems in the assessment area are to climate change and explain whether there has been research done on the interactions between climate change and potential development for this area. d) Describe all innovative approaches being explored and invested in by Canada to enable development in the assessment area, across all possible sectors, beyond mining.	**Carbon storage:** As stated above, projects within the RoF may have an impact on peatlands and carbon sinks. Projects may result in a positive or negative impact on the carbon sequestration of these carbon sinks. Impacts are highly site-specific based on the vegetation, soil, minerology and terrain of the area being impacted. The Strategic Assessment on Climate Change Technical Guide represents the best available guidance for the evaluation of projects on carbon sinks. **Wildlife habitat & ecological function:** The 2023 ECCC FAAR response includes information on factors to be considered in the RA related to wetlands, linear projects (section 3, pages 37-38) and wetlands, mining (section 3, page 38). These considerations apply to peatlands, as one type of wetlands present in the region, and include potential impacts and adverse effects to wetlands (including peatlands) and wildlife using them. ECCC has provided responses to questions posed by the Impact Assessment Agency of Canada related to peatlands for the Marten Falls Community Access Road (https://registrydocumentsprd.blob.core.windows.net/commentsblob/project-80184/comment-63251/ECCC%20Response%20to%20Enclosure%201%20Targeted%20Questions%20-%20Marten%20Falls%20draft%20IS%20-%2023%20June%202025.pdf). ECCC does not have responses for (b) and (c) at this time. d) Describe all innovative approaches being explored and invested in by Canada to enable development in the assessment area, across all possible sectors, beyond mining. ECCC is advancing risk-based approaches and tools to enable streamlined project development while maintaining rigorous standards for biodiversity, including for peatlands. This includes, for example, improved mobilization and use of existing data for predictive modeling, integration of risk assessment approaches into Impact Assessment advice, use of pathways of effects models linked to standard mitigation measures, standards and tools for offsetting (including exploring potential for habitat banking aligned with the Mitigation Hierarchy), and adaptive management best management practices.

Attachment I: ECCC Projects and Initiatives Relevant for the Ring of Fire Area

Table 1. Summary of projects and initiatives in the Ring of Fire area where ECCC is involved in the project. The column headings align with the questions in 1 (a) – (c). Please note that a "N" under "Indigenous Nations collaboration" does not indicate that there is not the opportunity for collaboration. If there is interest in collaboration, please let us know and we can discuss potential collaboration opportunities (pending resource availability).

Project/Initiative Name	Description	Timeframe	Lead Organization	Other Collaborators	ECCC Role	Geographic Location	Indigenous Nations collaboration	Present to RAWG? (Y/N)
1. Quantifying Carbon-Wildlife Ecosystem Service Bundles Where the James Bay Lowlands meet the Boreal Shield: Terrestrial Wildlife, Carbon and Vegetation	This five-year project will measure various soil attributes (e.g. carbon storage, peat depth, decomposition vulnerability) and vegetation (% cover by species) in the Western James Bay Lowlands and adjacent Ontario boreal shield. Models that show how soil carbon amounts, vegetation composition, and wildlife occurrence are linked across the landscape will help ECCC and others identify areas of particular importance within Ontario's northern peatland systems for sequestering and storing carbon to fight climate change while achieving biodiversity benefits.	2023-2028	University of Guelph, Wilfrid Laurier University	Natural Resources Canada (NRCan), Ontario Ministry of Natural Resources (MNR), Wildlife Conservation Society.	In addition to providing funding, ECCC helped assemble the project team and develop the project proposal. ECCC provides advice on an ongoing basis and ECCC participated in the summer 2025 data collection.	See Figures 1 and 2.	Y – Project Lead Catherine Dieleman works closely with Matawa Four Rivers Environmental Services to identify and create appropriate opportunities for development of positive relationships with local communities.	No, ECCC could help arrange for the project leads to give a presentation.
2. Collaboratively model cumulative effects through genomic profiling on Ontario Caribou in anticipation of questions about baseline conditions and the cumulative effects of the proposed mining activities in the RoF area	This project contributes to a collaborative research effort to analyze over 3600 caribou fecal samples collected through systematic surveys across the Far North region of Ontario in anticipation of questions about baseline conditions and the cumulative effects of the proposed mining activities in the RoF area. The results will be used to provide accessible baseline information on the occurrence and status of Boreal Caribou and Eastern Migratory Caribou in the RoF area, and to produce genetic-based measures of connectivity and diversity to assess the incremental impact of planned and future individual mining and road projects. See GCXE22S093 in March 2025 ECCC FAAR Response, in the funding contributions table, pages 28-31.	2022-2026	ECCC, Trent University	N/A	In addition to providing funding, ECCC conducts extensive annual field surveys (2021-2025), process fecal samples for DNA analysis, conduct data analysis and spatial modelling. ECCC uses the	Ontario, with a particular focus on northern Ontario and the RoF. See Figures 3 and 4.	N	Y

					results of these projects to inform the planning and implementation of caribou conservation measures including stewardship actions.			
2. a) Integrated Dynamic Networks: A novel framework for delineating the spatial distribution of caribou ecotypes	This project aims to develop an Integrated Dynamic Networks (IDN; see Figure 4) framework that applies social and kinship network theory to integrate multiple data types: genetic relationships (parentage, sibship, relatedness), spatiotemporal co-occurrence, GPS-based movement, and expert knowledge. Caribou are represented as nodes in the networks, with edges connecting individuals based on genetic or spatiotemporal relationships (i.e. they occur at the same time or in the same space). The framework's modular design allows users to assess how different data streams (such as genetic relationships and spatiotemporal co-occurrence) influence ecotype inference (i.e., boreal vs. migratory), providing flexibility in the approach. The results confirm that both ecotypes occur in the Far North boreal range during winter and move long distances. Notably, Eastern Migratory Caribou extend farther south than currently recognized by COSEWIC.							
2. b) Genomics insights into the recent evolution of ecotypes: delineating at-risk caribou populations with high gene flow	Ecotypes hold unique behavioural and/or life history diversity. Identifying genetic differences among ecotypes is critical for informing their designations and conservation status. However, detecting these differences can be challenging, particularly for ecotypes that are based on behaviour, share habitats, and exhibit high gene flow. In Ontario and Quebec, two ecotypes of Woodland Caribou (*Rangifer tarandus caribou*) with overlapping distributions in winter are recognized: Eastern Migratory and Boreal Caribou are morphologically similar yet are distinguished by their calving strategy and conservation status. While Eastern Migratory Caribou move between the forest and coastal tundra during spring and summer and are proposed to be Endangered, Boreal Caribou remain in the forest year-round and are listed as threatened. The findings of this study revealed that ecotypes in Ontario and Quebec are genetically distinguishable. The different genomic variants found in each province and the absence of "supergenes" suggest a recent and independent evolution of the eastern migratory ecotype in each province. In Ontario, the levels of interbreeding between ecotypes indicate that the overlapping zone is larger than what the current distribution reflects. These results add to our current knowledge of caribou genetic structure and movement in the region and can help inform future management strategies.							
2. c) Specific peatland composition is a major driver of predicted Woodland Caribou winter habitat suitability in northern Ontario	Species distribution modeling and environmental variables with ecological relevance to Woodland Caribou were used to predict and map suitable winter Woodland Caribou habitat in northeastern Ontario, Canada. The best model suggests that peatland types and the climatic effect of James and Hudson Bay may best indicate Woodland Caribou habitat suitability (68.8% cumulative relative influence). Based on this, a predictive model identified a large and clustered zone of winter Woodland Caribou habitat centered within the transition between the ecozones (Ontario shield to Hudson Bay lowlands). By accounting for local-scale aspects of Woodland Caribou habitat and climatic variables, our model provides comprehensive predictions of Woodland Caribou winter habitat suitability in this transition zone. Additional investigation of the role of peatland type in Woodland Caribou habitat suitability in different seasons and different regions may help further understand Woodland Caribou distribution and habitat use. See article: Bioclimatic, terrain, and specific peatland composition are major drivers of Woodland Caribou winter habitat suitability in northern Ontario.							
3. Working together to improve the reliability and utility of Northern Ontario bird	ECCC leads the Northern Ontario Bird Modeling Working Group (NOBMWG), an informal initiative that brings together experts from federal and provincial governments, academia and environmental non-government organizations with expertise in statistical modeling, northern Ontario birds and bird habitats, and those who incorporate bird model outputs into financial,	2024-2027	ECCC	Birds Canada, Boreal Avian Modelling Project, Universite Laval, University of	ECCC co-leads the Northern Ontario Bird Modeling Working Group (NOBMWG) and	Ontario boreal shield and Hudson Bay Lowlands.	N	Y

models for decision making	human resource and survey decisions. Broadly, the working group aims to support efficient use of the emerging bird datasets and the development, evaluation, and appropriate use of models for northern Ontario birds. Description continued after Table 1.			Alberta, NRCAN, Ontario Ministry of Natural Resources and Forestry.	manages a G&C and contract that are supporting development of a prototype system for soliciting and synthesizing feedback on species distribution models from species experts and statistical reviewers. ECCC is also participating in the design and implementation of that system.			
4. Assessing and projecting cumulative effects of anthropogenic and natural disturbance on vegetation and wildlife in the RoF area	In anticipation of requests for science advice regarding cumulative effects associated with the Regional Assessment in the RoF area, ECCC led an effort to assess the usefulness of available modeling tools for projecting cumulative effects of natural disturbance and human activities on migratory birds and Boreal Caribou in the RoF region. These projects contributed to an assessment of the usefulness of available models for projecting cumulative effects of disturbance on wildlife in the RoF region, and collection and analysis of baseline data in the region. Please find details of all aspects of the project in Attachment V.	2021-2023	N/A	ECCC, NRCan, the University of Guelph, Wilfrid Laurier University, the Laval University, and the University of Alberta Boreal Avian Modeling project, and consultants from FOR-CAST Research & Analytics and Apex Resource Management Solutions Ltd (supported in part by GCXE21S046, GCXE21S047, GCXE22S048, and GCXE23S015).	Initiation, interpretation, and integration of components.	RoF area.	N	No, as our 2022 assessment is no longer current.

Project/Initiative Name	Description	Timeframe	Lead Organization	Other Collaborators	ECCC Role	Geographic Location	Indigenous Nations collaboration	Present to RAWG? (Y/N)
5. Prioritizing ethical space to support engagement among scientists and Indigenous communities in the RoF and beyond	Maintaining the integrity of Indigenous ways of knowing in research is impossible without transforming research governance and practice. Scientists and practitioners are seeking practical advice on how they can be a part of this transformation. To help serve this need, we identified twenty-six Action Items for ethical conduct when bridging Indigenous and western knowledge systems from an analysis of nine exemplary case studies. We offer A Growing Tree metaphor, and graphic, to unite the twenty-six Action Items into a holistic narrative and reflective tool. Our contributions can support western-trained scientists to consider alternatives to the dominant epistemic assumptions in research governance and practice. Yet, as depicted by A Growing Tree, we acknowledge that it is through nurturing relationships with Indigenous peoples and communities that appropriate actions and ways of embodying ethical values in practice will be learned for any specific context. See GCXE22S047 in March 2025 ECCC FAAR Response, in the funding contributions table, pages 28-31.	2021-2023	University of Guelph	ECCC	ECCC managed the contribution agreement (CA), helped advise project lead and contributed to discussions, analysis and writing.	The work includes example case studies from across Canada and Alaska.	N - This was a desk-top exercise during the Covid-19 pandemic. The CA recipient and several collaborators on the project are indigenous scholars. Discussion with Kim Jorgenson clarified that engaging with communities in the RoF region was inappropriate at the time.	N
6. New methods to optimize selection of priorities for habitat restoration, when resources are limited	This project aims to develop a novel approach to optimize restoration of land use features while explicitly considering the impact of those features in the surrounding landscape. The results can inform decisions about where to invest resources for habitat restoration.	2020-2027	ECCC	N/A	N/A	National (methods developed are designed to be applicable anywhere, but first empirical test locations TBD).	N	Yes, but it would likely be best at a later date. This is a work in progress. The theoretical portion of methods development is complete, but not empirical testing.
7. Integrating local demographic data with national demographic-disturbance relationships to help reduce	This project will develop methods and tools for making better use of available Boreal Caribou demographic data and demographic-disturbance relationships to reduce uncertainty in caribou demographic projections, and for assessing the merits of alternative monitoring scenarios. These tools and methods could be applied in the RoF region to ensure Boreal Caribou status projections are informed by best available information and are updated as new information becomes available. Note that the	2023-2026	ECCC	N/A	N/A	National.	N	Y

uncertainty in population projections for Boreal Caribou	project entitled "assessing and projecting cumulative effects of anthropogenic and natural disturbance on vegetation and wildlife in the RoF Area" (#4) provided context for ongoing work to improve caribou demographic and bird modeling tools, and to collect baseline data in the region.							
8. Establishing long-term monitoring sites in the Matawa member First Nation Homelands to support community capacity in carbon and biodiversity research to inform future decision making	NSERC Alliance Society proposal in development: ECCC and others have made substantial investments in collection of baseline carbon and biodiversity data in the Hudson Bay Lowlands and adjacent boreal shield ecozones. Some of these investments have also supported the development of Indigenous environmental monitoring capacity in the region, and of research partnerships that are grounded in solid relationships of trust and foundation-building. Many of the benefits of these large investments could be lost or eroded if not transitioned to a foundation of sustainable long-term monitoring, capacity building, and relationship building. Matawa Four Rivers Environmental Services is uniquely positioned to work with Matawa communities, Guardians and Western-oriented scientists to establish such a foundation. ECCC proposes to support Four Rivers to develop a long-term monitoring plot network to address community needs and priorities, grow and sustain research partnerships, and develop community capacity for carbon and biodiversity monitoring and decision making. Specifically, long-term monitoring plots will offer opportunities to monitor changes in aspects of biodiversity that are of interest to ECCC, and a carefully designed biodiversity monitoring plan for these plots will be an outcome of this project (not an input to it).	If funded, 2026-2030	Matawa Four Rivers Environmental Services, University of Guelph	N/A	ECCC is supporting development of an NSERC Alliance Society proposal and will continue advocating for the value and importance of the proposed project both within and outside ECCC.	Permanent sample plots near Matawa communities. Number and locations to be determined by communities and research partners if the project is funded.	Indigenous-led.	N
9. Developing climate smart solutions for critical habitat protection for Boreal Caribou in northern Canada	This project explores how the cumulative effects of climate change and resource extraction influence forest dynamics and the forest's ability to support Boreal Caribou and Indigenous communities inhabiting ecosystems in Northern Canada. The impact of changing fire regimes, increasing temperatures, and development on forest structure, composition and productivity will be modelled and used to quantify northern range expansions of deer and moose, as well as their predators. This information will be used to test the resiliency of different habitat protection strategies for Boreal Caribou under climate change. Part of the funds will be used to build research capacity within Indigenous communities to understand the impact of climate change and resource development on community wellbeing. Additional details are described below.	2024-2026	University of Saskatchewan	N/A	ECCC is helping develop the model to reflect Boreal Caribou habitat use and forecast changes in the distribution and abundance of caribou under different climate change scenarios.	National.	Y – In Saskatchewan.	N

Project/Initiative Name	Description	Timeframe	Lead Organization	Other Collaborators	ECCC Role	Geographic Location	Indigenous Nations collaboration	Present to RAWG? (Y/N)
10. Maximizing co-benefits for protecting large carbon stores and climate refugia for species at risk and migratory birds across Canadian ecosystems	This project aims to: 1) quantify changes in above and below ground carbon stores under climate change to identify "highways of carbon refugia", referring to interconnected areas of high carbon storage capacity that will remain more or less unaffected by climate change; 2) explore the relationship between carbon refugia and watershed quality across Canada; 3) quantify the co-benefits of protecting areas of both high carbon storage and high watershed quality to biodiversity, including migratory birds and species at risk.	2023-2026	University of Toronto		ECCC provided expertise on climate models and species distribution models and helped with the development of the framework that integrates carbon sequestration with Species at Risk.	National.	N	N
11. Using microclimate data to inform climate resiliency of the RoF regions: Improving predictions of climate change impacts on wildlife and development of climate-smart adaptation measures. (Part of Project 1)	This project uses microclimate data (collected through ECCC Project #21, below) to develop spatial data layers representing microclimate temperatures across the region and will contribute to a national scale project on microclimate mapping for climate resiliency. The work aims to inform landscape-scale impacts of climate change, land-use, and land-cover change on migratory birds, caribou, pollinator species, other species of concern. The microclimate work is part of the "James Bay Lowlands meets the Boreal Shield project" (see #1). Maps of microclimate will be used to identify climate change refugia within Ontario's northern peatland systems that will inform climate resilient landscapes while achieving biodiversity co-benefits.	2024-2028	ECCC	Western University	ECCC is leading the microclimate climate resiliency spatial mapping component of this work, in collaboration with Western University.	Microclimate data loggers were deployed along 29 sites in the RoF area.	Y – see Project 1.	Y- with input from collaborators.
12. Climate resilient species and ecosystems of the RoF: Science and Decision-support Tools for Adaptation, Compliance and	This work includes performing climate change vulnerability assessments for integration into terrestrial Schedule 1 Species at Risk Status Reports and Recovery Strategies and migratory bird conservation under responsibility of ECCC. Specifically, the work will include assessments of priority species, species of concern (e.g., those anticipating assessment), species at risk, and migratory birds that are found within the RoF Assessment area. This includes Rusty Blackbird (*Euphagus carolinus*), Hudsonian Godwit (*Limosa haemastica*), Lesser Yellowlegs (*Tringa flavipes*), and Woodland Caribou boreal population. By contributing to	2024-2029	N/A	COSEWIC, NRCan.	ECCC is primary investigator and scientific authority.	RoF region.	This project is in early stages of development. It is anticipated that output review will engage with species experts.	Yes, however, this component of the project is still under development and requires additional funds.

Sustainable Landscapes	Species Assessments undertaken by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), outputs of climate change vulnerability assessments will inform legal obligations and contributes essential decision-support to COSEWIC and inform ECCC recovery strategies.							
13. Hudson Bay Lowlands (HBL) Ecosystem mapping: Using Satellite Earth Observations (mainly Landsat)	We have modelled ecosystem extents in the Hudson Bay Lowlands (HBL) using the e-CNVC legend of ecosystem vegetation. We have also used peat depth locations and peat/carbon accumulation rates to model peat depth and carbon stock across the HBL. Using location records from Global Biodiversity Information Facility, the Canadian Museum of Nature and NatureServe Canada, we have modelled biodiversity as a function of individual species occurrence (Species Distribution Models) as well as a community level biodiversity (Generalized Dissimilarity Modelling) with a focus on vegetation taxa. Most products are complete; papers are being written and data prepared for publication.	-	ECCC	Partners include Parks Canada, academics, Canadian Museum of Nature, NatureServe Canada.	Our role has been to develop independent variable suite (climatic etc.) and complete the modelling. Parks Canada has led and funded the data collation from institutions.	HBL.	Y - ECCC has been working with the Mushkegowuk Council. We have a G&C agreement with them (multi-year) to support their efforts, including braiding knowledge and understanding their needs from a decision support system.	Y
14. HBL Change over 40 years	Using the Landsat satellite archive, we have assessed the surface water changes of small bodies of water over the entire HBL and have begun analysis to determine the potential drivers of change (i.e. beaver expansion/alteration). We have also processed the Landsat time series using a statistical model to transform the raw spectral information into estimates of greenness (vegetation), wetness (water), and brightness (rock, bare soil, lichen) to detect trends over 40 years. We are doing an intensive analysis of the Victor Diamond Mine site on the Attawapiskat River to look at changes in the vicinity of this mining operation to inform what may happen in the RoF. In completing the analysis of the entire ecozone, we can gain insight into drivers of change, for example local change (i.e., mine development) vs global (i.e., climate change). The surface water paper has been published, and data are available. Other analyses are in progress.	-	ECCC, NRCan		ECCC is leading this work, other than some of the beaver work which is led by Natural Resources Canada.	HBL.	Y – See above.	Y
15. Coastal ecosystems	We are completing detailed coastal marsh ecosystems using Radarsat imagery to assess blue carbon stocks (carbon stored in coastal ecosystems) as well as biodiversity aspects.	-	ECCC	N/A		RoF area.	Y – See above.	Y

Project/Initiative Name	Description	Timeframe	Lead Organization	Other Collaborators	ECCC Role	Geographic Location	Indigenous Nations collaboration	Present to RAWG? (Y/N)
16. Long term Hydrometric Monitoring in the RoF region	Hydrometric gauges are installed on various rivers, including the major river systems in the Ring of Fire Assessment Area: Abitibi River (04ME003), Attawapiskat River (04FB001, 04FC001, 04FC002), Ekwan River (04EA001), Kenogami River (04JG001), Missinabi River (04LJ001, 04LM001) , Moose River (04LG004, 04LGX01), the Lower and Upper Albany Rivers (04GD001, 04HA001, 04HA002), and the Winisk River (04DA001, 04DC001). Remaining gauges are on tributaries to those primary gauges. Water level data and discharge measurements are collected and are available continuously via public website. Data is available to the public at: Water Level and Flow - Environment Canada. More information is available in the March 2025 ECCC FAAR Response on page 20-21.	1920-2025	ECCC	MNR – co-funder under the Canada-Ontario Agreement on Hydrometric Monitoring.	ECCC operates and maintains physical infrastructure at locations across Canada, including Northern Ontario.	RoF Region of Ontario stations as noted on the ECCC Station Map - Figure 5.	Y - Consultation with Indigenous communities took place prior to new installations in the last 15 years. This consultation was led by the through the Far North Branch of the Ontario Ministry of Natural Resources (MNR), who was the funding partner for those installations.	N
17. Water Quality Sampling at Hydrometric Monitoring Stations by the National Hydrometric Service	Water quality data is usually not collected, but sampling has in recent years become a funded activity by MNR/MECP for five Hydrometric Stations in the Ring of Fire area during the “open-water” (non-winter) months. These activities took place during 2017-2024 (Selected Hydrometric Stations: 04FC003, 04FC001, 04FC002, 04FB001, 04EA001). Samples are analyzed by MECP. Water quality sampling was not completed from 2020 to 2022, but did resume in 2023, completed partially in 2024, and not completed in 2025. Gauges are installed on various rivers, including the major river systems in the Ring of Fire Assessment Area: Attawapiskat River (04FB001, 04FC001, 04FC002), Ekwan River (04EA001) and one is on a tributary to the Attawapiskat River (04FC003). More information is available in the March 2025 ECCC FAAR Response, on page 20-21.	2017-2024	Ontario Ministry of Environment, Conservation and Parks (MECP)	MNR – administrative collaboration, and co-funder under the Canada-Ontario Agreement on Hydrometric Monitoring.	ECCC completes the physical collection of baseline water quality sample collection during visits to five (5) Hydrometric Monitoring Locations, determined by MECP. ECCC is a co-funder of the hydrometric gauges within the Canada-Ontario Agreement on Hydrometric Monitoring.	Central Ring of Fire stations as noted on the ECCC Station Map – Figure 5: 04FC003, 04FC001, 04FC002, 04FB001, 04EA001.	N – ECCC is uncertain whether MECP completed any communications with Indigenous Nations and communities.	N

Project/Initiative Name	Description	Timeframe	Lead Organization	Other Collaborators	ECCC Role	Geographic Location	Indigenous Nations collaboration	Present to RAWG? (Y/N)
18. National Adaptation Strategy (NAS)	At ECCC, the work includes developing and calibrating hydrological models for watersheds across Canada including those in the Ring of Fire area of interest. While the work is ongoing and still in development, the expectation is that it will lead to baseline hydrologic models that will allow for consideration of changes in the basins, including those that may occur from climate change. The Priority Climate Data, Services, and Assessment program is also under the National Adaptation Strategy. The goal of the program is to provide access to new climate information, data products, and services that enable Canadians to readily account for future climate conditions in their decision strategies, actions, and planning and infrastructure investments. The implementation of this program aims to project the frequency and intensity of climate extremes for more environmental variables and finer spatial resolution. Priority topics are: Climate modelling, Canada-focused climate projections, freshwater availability assessment, and climate science assessment. This program also represents an expanded investment in the Canadian Centre for Climate Services (CCCS) to make it easier for organizations to assess the vulnerability of populations to climate change in a manner that aligns with their risk and decision-making frameworks.	1950-2014 – Historical climate Hydrological model simulation, calibrated with observations 2014-2100 – Future climate Hydrological model simulation	ECCC	Various academic institutions.	ECCC is leading the project and calibrating the hydrological models.	All of Canada and the transboundary including the RoF Region of Ontario.	Y - Indigenous perspectives from across Canada are incorporated into the assessment process, including in the writing of the 2026 edition of the Canada's Changing Climate Report.	N
19. Long term Atmospheric Monitoring in the RoF region	ECCC manages a geographically dispersed system of networks that monitor weather and climate across Canada. In the Ring of Fire region, these networks currently include seven automatic surface weather stations (AWS) collecting long-term climate data, five of which are Reference Climate Stations (RCS; having at least a 30-year climate record), and 5 lightning detection sensors operated as part of the Canadian Lightning Detection Network (CLDN) in collaboration with a private contractor (see ECCC Station Map – Figure 5). The AWS sites observe air temperature, humidity, precipitation accumulation, precipitation intensity, snow depth, air pressure, and wind speed and direction; the lightning sites detect cloud-to-ground and some cloud-to-cloud lightning strikes. The resulting data and information are essential inputs to ECCC's modelling	Ongoing since ~1983	ECCC	Vaisala is a private contractor responsible for processing raw data from the lightning sensors.	ECCC is the weather observation data steward on behalf of the Government of Canada.	Canada-wide, Currently in the Ring of Fire region (see ECCC Station map – Figure 5) ECCC has 7 Automatic Surface Weather Stations (AWS) in the region - at Peawanuck (ID: 6016295), Ogoki Post (ID: 6075788),	Y - ECCC has Automatic Surface Weather stations at two First Nations communities in the Ring of Fire: Ogoki Post (**Marten Falls First Nation**), and Weagamow Lake (**North Caribou Lake First Nation**). Both the Marten Falls and North	N

	and forecasting systems and are made available directly to clients and the Canadian public. *Data access:* ECCC's Historical Climate Archive is available at http://climate.weather.gc.ca/ or through the Ontario Climate Services office http://climate.weather.gc.ca/contactus/climate_services_e.html. Official weather warnings and forecasts are available at http://weather.gc.ca/ and real-time weather observations are available in XML format on the ECCC datamart at https://dd.weather.gc.ca/observations/swob-ml/ Current lightning strike information can be accessed via the Lightning layer of the map at https://www.weather.gc.ca/. More information on this layer can be found at Lightning - Canada.ca.					Weagamow Lake (ID: 6019400), Big Trout Lake (ID: 6010740), Lansdowne House (ID:), Moosonee (ID: 6075429), and Geraldton Airport (ID: 6042719). Five of these AWS are also considered Reference Climate Stations (Ogoki Post and Weagamow Lake are NOT RCS). In addition, ECCC has 5 lightning detection stations at Big Trout Lake, Kashechewan, Moosonee, Geraldton and Peawanuck.	Caribou Lake First Nation communities were consulted in advance of the site selection for the Ogoki Post and Weagamow Lake automatic surface weather stations. ECCC used local contractors to install the monitoring infrastructure station at Weagamow Lake. ECCC successfully negotiated land lease agreements with both the Marten Falls and North Caribou Lake First Nation communities.	
20. Communication and engagement related to survey work	Since 2020, ECCC has engaged and communicated with Indigenous communities and organizations within and near the Ring of Fire region to inform them about ongoing ECCC surveys. This includes providing information about survey plans, providing opportunities for input and feedback to survey design and sampling locations, sharing results, delivering virtual presentations to discuss surveys and results, attending and presenting at in-person meetings upon request, and sharing data upon request.	Ongoing	ECCC	N/A	ECCC distributes communications on upcoming surveys and provides opportunities for input and feedback.	Throughout Ring of Fire Area. See Fig 2 in March 2025 ECCC FAAR Response for locations.	Y	Y – ECCC can discuss engagement activities if this is of interest. The information shared in engagement and communication is all covered in

								the line below on addressing information gaps.
21. Addressing information gaps in Ontario's Far North	Since 2020, ECCC has worked to identify and help address information gaps in the Ring of Fire region related to wildlife, with the goal of supporting informed decision-making in the region. This includes deployment of data loggers to capture microclimate data, alongside camera traps and autonomous recording units (ARUs) used to record sound. See the additional data list provided as part of the March 2025 ECCC FAAR Response for a full list and the presentation provided to the RAWG in June 2025 for an overview of wildlife data collection initiatives.	2020 – Present	ECCC		ECCC leads and participates in a range of surveys including conducting surveys and coordinating work by experts. See the March 2025 ECCC FAAR Response for more details on some of the project areas.	See maps provided in the March 2025 ECCC FAAR Response for information on surveys with ECCC involvement.	N – See Above.	Y – ECCC may be able to present on specific topics/species of interest if requested.
22. Scientific analysis	Using data from ECCC surveys and other available data sources, ECCC is working to summarize and analyze available information about wildlife and wildlife habitat in the Ring of Fire region. See page 15 of the March 2025 ECCC FAAR Response for a list of analysis and reports completed to-date.	2020 – Present	ECCC	Many. See individual publications for lists of collaborators.	See description.	See above.	N	Y – ECCC may be able to present on specific topics/reports of interest if requested.
23. Development of Tools and Advice	ECCC applies available information to develop tools and advice to support informed decision-making. This includes identification of threats and potential effects of development, development of pathways of effects and development of mitigation and offsetting options for habitats (e.g. peatlands) or species (e.g. caribou).	2020 – Present	ECCC		See description.	Throughout the RoF Region.	N	N – tools are still under development.

Additional Information:

Project/Initiative Name: 3. Working together to improve the reliability and utility of Northern Ontario bird models for decision making

Additional Details/Description: Although we expect that models informed by new data will be more reliable, the RoF region is vast, heterogeneous and remains sparsely sampled, so many aspects of modeling are expected to remain uncertain. Experience with the use of bird models in decision processes has clarified that understanding and communicating uncertainty in this data-sparse region is essential to reliable decision making, and that there are risks associated with misuse and misinterpretation of large scale (national or provincial) bird modeling results in regional and local assessments. Supported by ECCC (GCXE25S033, detailed below) and informed by working group members, the Alberta Biodiversity Monitoring Institute is leading development of tools to support model evaluations and the appropriate use and interpretation of bird model products for informing decisions in the Hudson Bay Lowlands and other sparsely sampled regions. Anticipated outcomes include:

- a prototype system for soliciting and synthesizing feedback on species distribution models from species experts and statistical reviewers,
- communication tools and guidance on how to use models and their reliability as inputs to evaluating and communicating biodiversity co-benefits, estimating cumulative effects, predicting impacts, and supporting decisions pertaining to species at risk and migratory birds, and
- methods to incorporate model reliability into an adaptive modelling framework to improve model products.

Working group members will use a variety of quantitative methods for model evaluation and comparison and will continue to integrate new information into models as it becomes available. We expect that an iterative process of model development, evaluation, refinement and interpretation using a variety of methods will continue to improve the reliability and usefulness of bird models in northern Ontario.

GCXE25S033: Development of tools to support appropriate use and interpretation of bird model products for informing decisions in the Hudson Bay Lowlands (HBL) and other sparsely sampled regions. Understanding and communicating uncertainty in the HBL is essential to reliable decision making, and there are risks associated with misuse and misinterpretation of nationally developed bird modeling results in regional and local assessments. The project will leverage and adapt the efforts of the Northern Ontario Bird Modeling Working Group (NOBMWG), since these efforts are focused on scales larger than the HBL and are intended for provincial and national initiatives that do not address the need to support regional and local decisions in the HBL. This project entails developing guidance and tools for communicating model results, uncertainties and appropriate uses to relevant actors in decision making processes in the Hudson Bay Lowlands (e.g. Parks Canada, ECCC, Indigenous organizations, IA proponents and consultants); designing the framework for a model evaluation system that leverages expert knowledge to improve model results; supporting development of model evaluation system tools; and supporting participation by NOBMWG members in these initiatives.

Project/Initiative Name: 9. Developing climate smart solutions for critical habitat protection for Boreal Caribou in northern Canada

Additional Details/Description: The models will:

a. Advance understanding of cumulative stressors on Boreal Caribou;
b. Inform how the risk of various levels of anthropogenic disturbance will change under different climate change scenarios and will link landscape change to the likelihood of maintaining self-sustaining populations of Boreal Caribou, which is a recovery goal ;
c. Provide information to inform impact assessments that includes consideration of the consequences of increased anthropogenic activity on Indigenous communities and their well-being in the northern boreal ;
d. Inform on the effects on the Indigenous peoples who use and depend on that ecosystem for cultural and livelihood needs, including wild food.

The following projects are taking place outside of the RoF Area, but may be of interest:

1. **Project/Initiative Name:** Mushkegowuk First Nations Indicators and Metrics of Forest Integrity

Timeframe: G&C: 2024- 2026. Alliance Society: 2025 - 2030

Description: The geographic focus of the project is the managed forest within Mushkegowuk traditional territory, which is outside the regional assessment area. Note that the G&C project is one component of a larger NSERC Alliance Society funded initiative led by York University entitled “An AI-driven approach that incorporates Two-Eyed Seeing to the accurate quantification of forest vegetation and integrity for nature-based climate solutions”. See GCXE25S038 in March 2025 ECCC FAAR Response, in the funding contributions table, pages 28-31 to Mushkegowuk Council.

ECCC role: ECCC supports the bird modeling component of the work by ensuring trainees have access to the data, tools, and expertise required for them to build on and learn from a variety of other Northern Ontario bird modelling initiatives.

Region: Managed forest within Mushkegowuk traditional territory - outside the regional assessment area.

Indigenous and Community Involvement: Mushkegowuk Council and Wahkohtowin Development GP Inc. are collaborators on the project.

Present to RAWG? No. Contact project lead Baoxin Hu (York University) or G&C lead Vicki Sahanatien (Mushkegowuk Council) for details.

2. **Project/Initiative Name:** Methods used to assess habitat connectivity for Boreal Caribou in Eastern Canada

Timeframe: 2023-2026

Description: This project explores the methods used to assess habitat connectivity for Boreal Caribou in Eastern Canada, in order to provide recommendations for the inclusion of connectivity metrics in impact assessments. Note that, due to limited data in the RoF and Ontario, the case study portion of this work is focused on Quebec. Results may be relevant for RoF.

ECCC role: In-house project – no external collaborators.

Region: Quebec

Indigenous and Community Involvement: N/A

Present to RAWG? Yes, however, this project is in progress so at this point results are preliminary.

3. **Project/Initiative Name:** Restoration and offsetting of Boreal Caribou habitat in the context of impact assessments in Canada

Timeframe: 2023-2026

Description: This project aims to improve knowledge on best practices for habitat restoration and conservation offsets tailored to the needs of Boreal Caribou in the context of cumulative impact assessments for resource extraction activities in Canada. It supports ECCC's work to develop an offsetting tool for Boreal Caribou, to help offset (balance against) the adverse cumulative impacts arising from industrial developments on this species at risk. It also generates improved scientific knowledge on best practices for Boreal Caribou habitat restoration and conservation offsets that can be integrated into a decision support tool, to use in the framework of providing advice to federally assessed impact assessment projects. The final production of ECCC's offsetting tools will improve the efficacy of the impact assessment process by providing the federal government and proponents of industrial activities with clear guidance to plan offsetting in the context of project development proposals. These tools are currently lacking for Boreal Caribou, a species that is often identified as a valued environmental component in impact assessments, being a species at risk of high priority for the government.

ECCC role: ECCC is co-PI of this work in collaboration with Université du Québec à Rimouski (through a G&C GCXE24S059).

Region: The focus of this work is Quebec, but we hope to expand it to Eastern Canada.

Indigenous and Community Involvement: N

Present to RAWG? Yes, however, note that this project is still under development. Preliminary results will start to become available later in 2026.

4. **Project/Initiative Name:** Development of science-based approaches to assessing and managing regional cumulative effects that promote biodiversity conservation and sustainable development

Timeframe: 2020-2025

Description: The inclusive approach to cumulative effects assessment (CEA) developed through this research is highly relevant to the RoF Regional Assessment for several key reasons. The description below draws on the guiding principles, and the goals and objectives related to cumulative effects outlined in the Terms of Reference (https://iaac-aeic.gc.ca/050/documents/p80468/158865E.pdf):

- Centering Indigenous Values and Knowledge: The RoF Regional Assessment emphasizes placing Indigenous values, interests, and priorities at the forefront. The inclusive CEA approach developed through this research project aligns with that intent by integrating Indigenous knowledge systems and perspectives throughout the assessment process, fostering collaboration between Indigenous communities and government bodies. The methods used in this research provide a practical framework for embedding Indigenous cultural and ecological priorities into decision-making processes, ensuring that land and marine use planning is reflective of Indigenous worldviews.

- Collaborative and Participatory Methods: The regional assessment in the RoF aims to create meaningful opportunities for Indigenous communities to participate in knowledge sharing and governance. The CEA approach developed through this project has already demonstrated how collaborative and trauma-informed methods can engage a wide range of knowledge holders, from Indigenous experts to government stakeholders. This is essential for ensuring that regional assessments in the RoF are inclusive, equitable, and respectful of Indigenous sovereignty.

- Assessing Cumulative and Long-term Impacts: One of the objectives of the RoF Regional Assessment is to consider cumulative effects and the long-term sustainability of development activities. The technical advances made in the CEA research, particularly the ability to account for both direct and indirect cumulative impacts, can provide valuable insights for understanding how multiple developments interact over time and across ecosystems. This is critical for developing sustainable regional strategies that balance ecological health with community well-being.

- Guidance for Regional Planning: The publication (above) offers guidance for replicating inclusive and accessible CEA processes, which can inform the RoF Regional Assessment as it seeks to develop frameworks for considering future development scenarios. The lessons learned from working with First Nations in British Columbia could be applied to improve the inclusivity, effectiveness, and legitimacy of the RoF Regional Assessment, ensuring that both Indigenous and non-Indigenous stakeholders have a meaningful voice in shaping sustainable futures.

ECCC role: ECCC was a co-PI of this work, in collaboration with the University of British Columbia (through a G&C GCXE20S013 in March 2025 ECCC FAAR Response, in the funding contributions table, pages 28-31).

Region: Central west coast of British Columbia (Central Coast) in the territories of the Kitasoo Xai'xais Nation, Nuxalk Nation, and Wuikinuxv Nation.

Indigenous and Community Involvement: This project was an invited collaboration with the stewardship authorities of the Kitasoo Xai'xais Nation, Nuxalk Nation, and Wuikinuxv Nation. Community members of all Nations participated in meetings and workshops to share their interests, values and knowledge with the project.

Present to RAWG? Yes.

Maps and Other Figures:

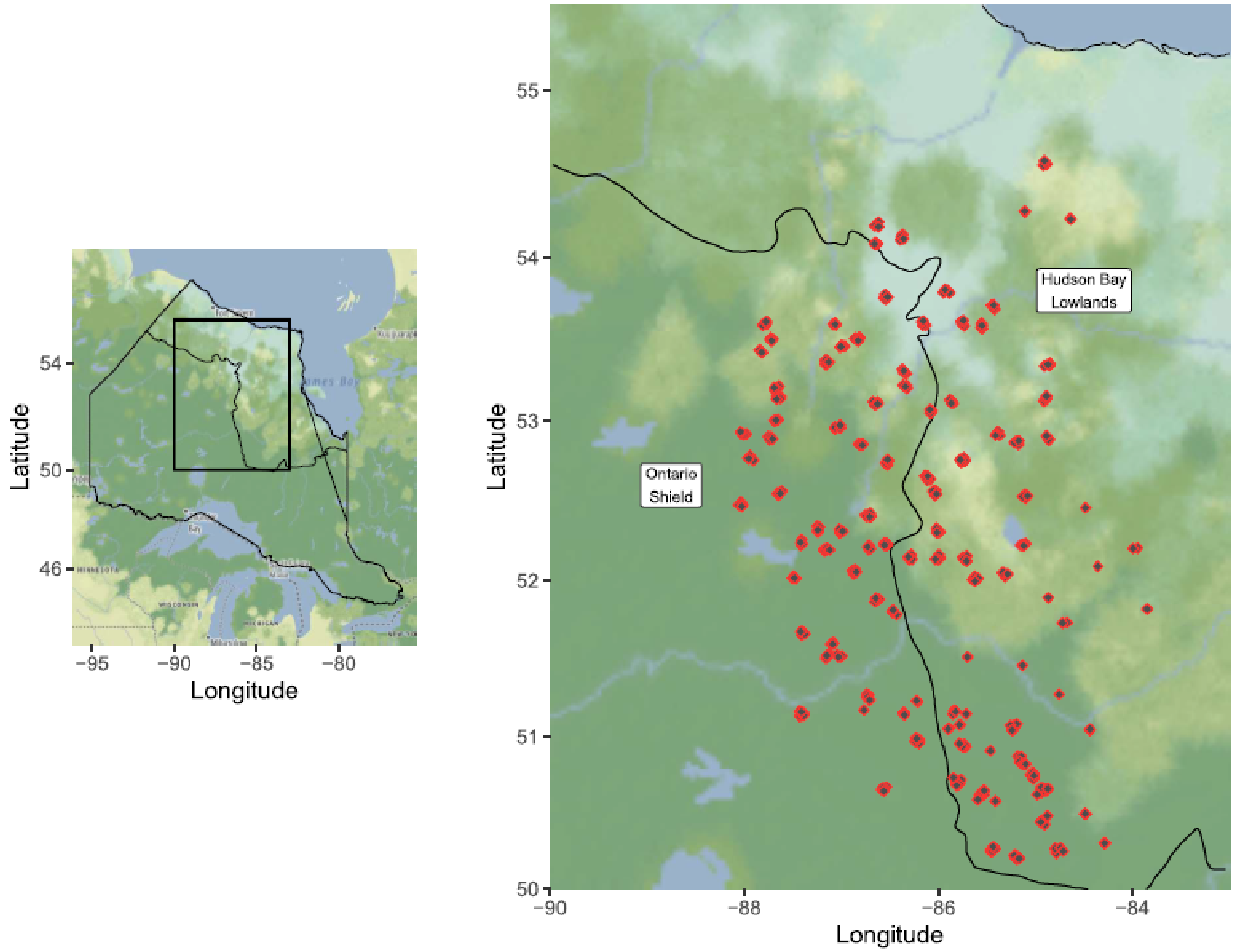


Figure 1. Camera trap and vegetation photo locations.

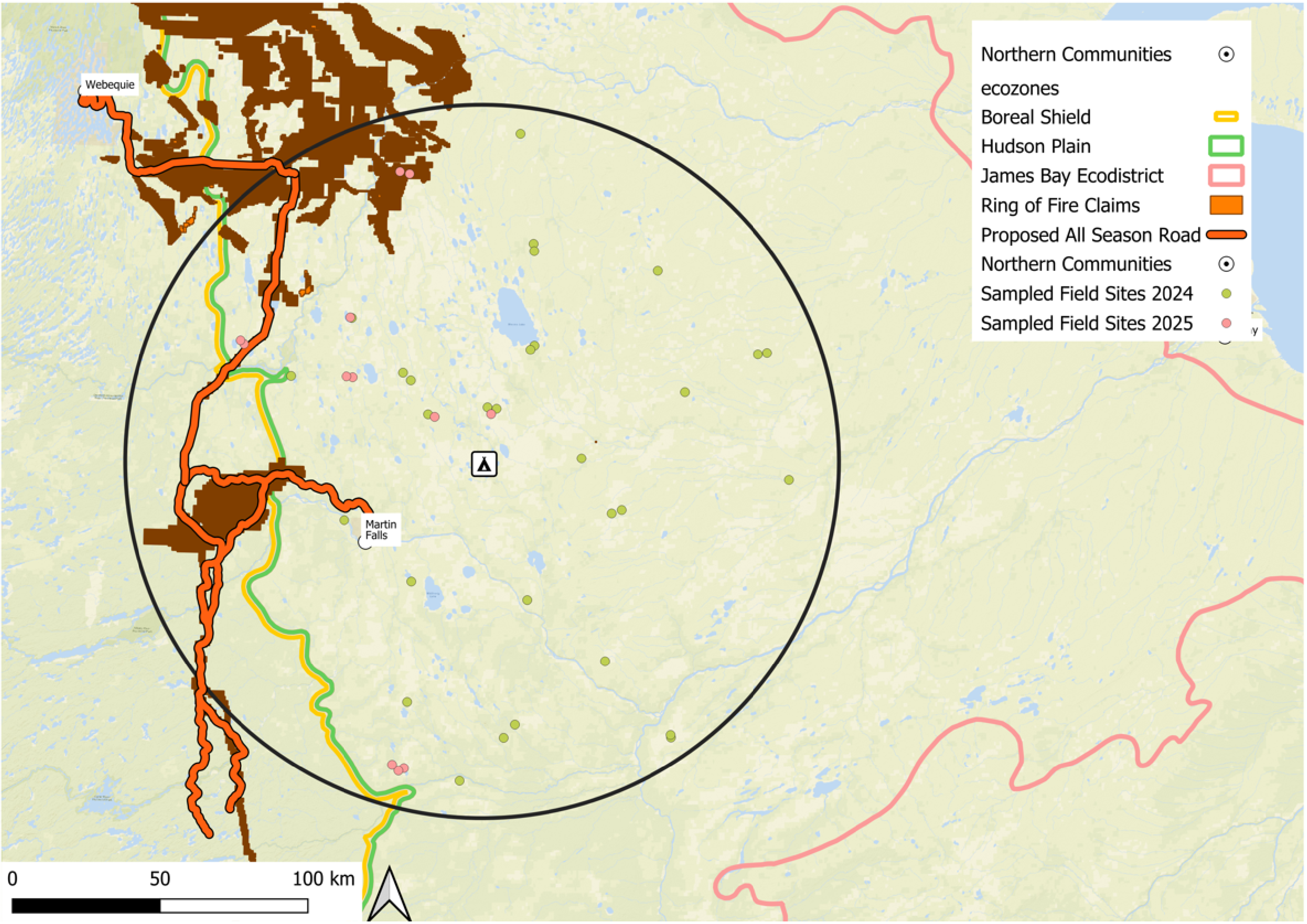


Figure 2. Peat core and vegetation plot locations sampled in 2024 and 2025.

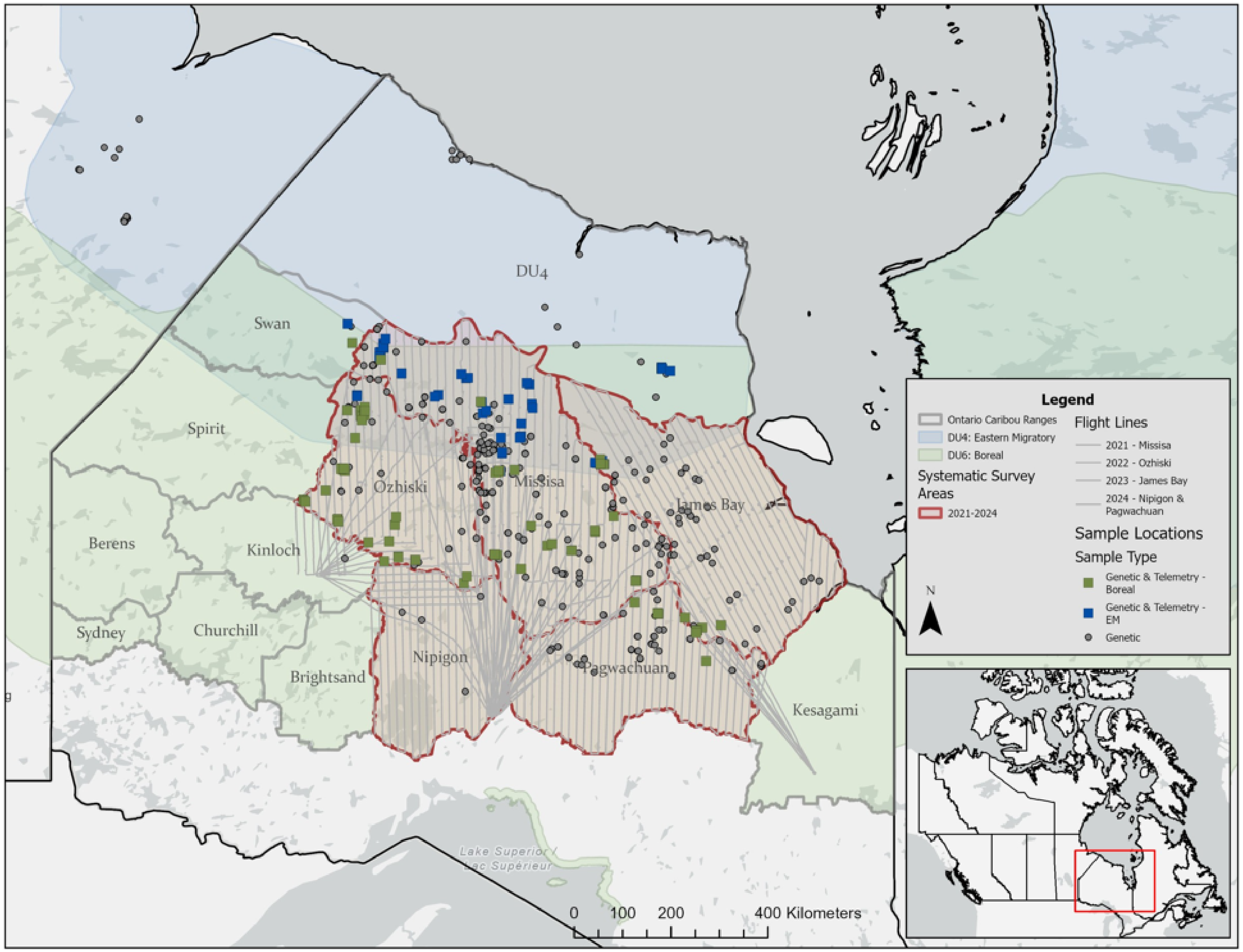


Figure 3. A map showing the extent of the data collection for genetic analysis.

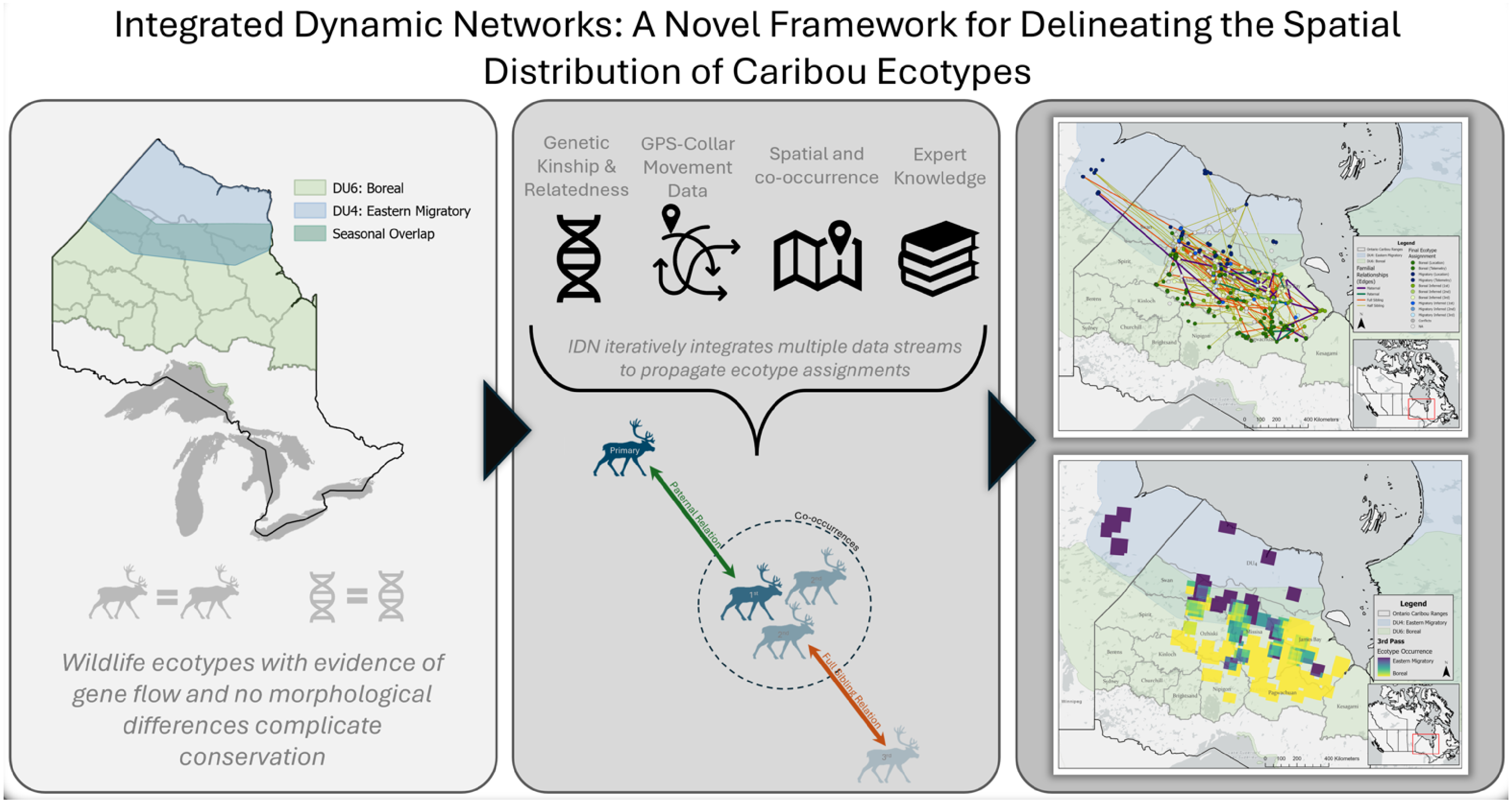
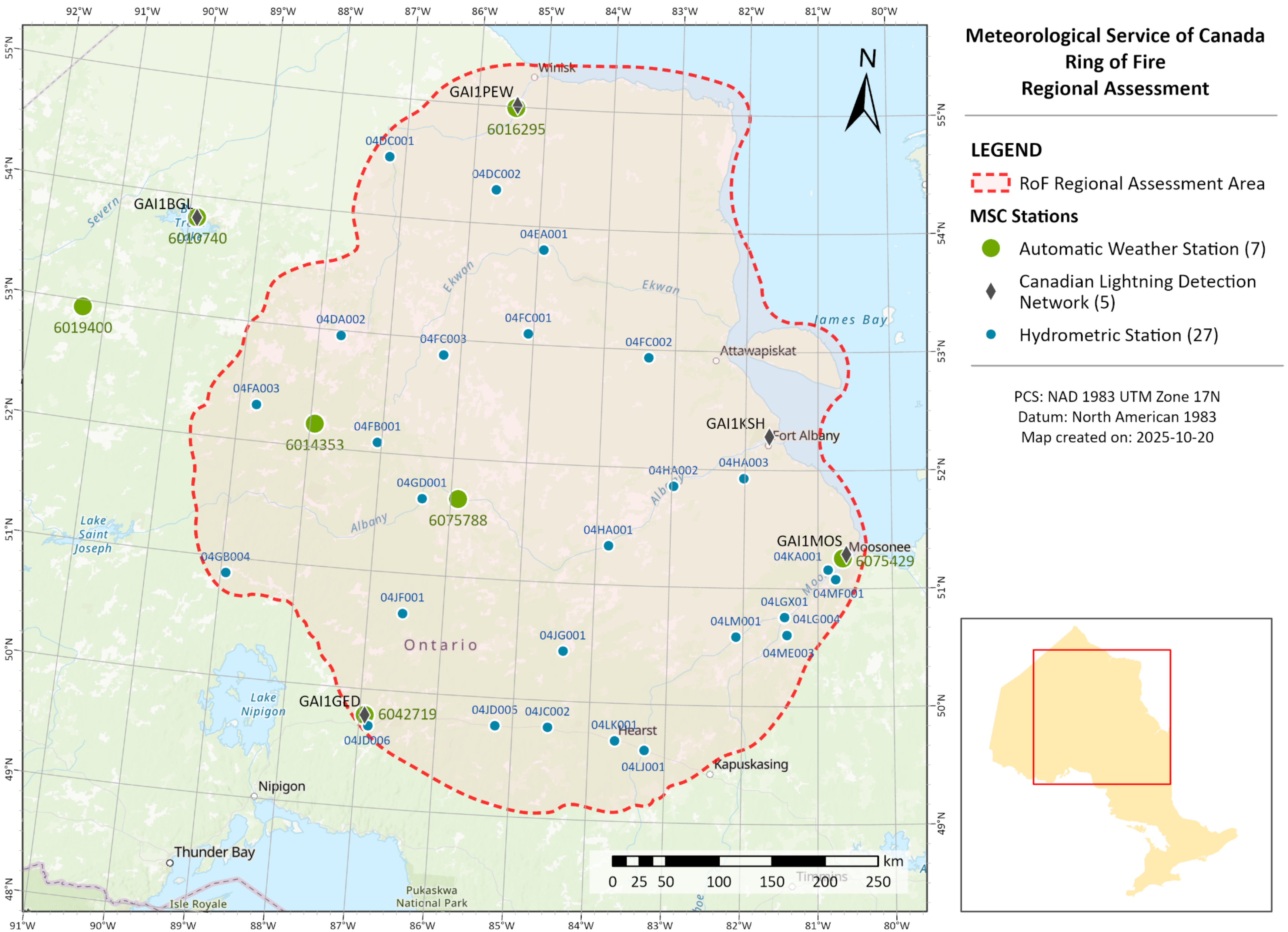


Figure 4. A graphic abstract summarizing how the genetic data was analyzed to inform the extent of the distribution of Boreal and Eastern Migratory Caribou.



Environment and Climate Change Canada | Environnement et Changement climatique Canada

Figure 5. Map of Meteorological Service of Canada Ring of Fire Regional Assessment.

Attachment II: Priority Topics Identified by the Working Group – Information and Gaps

ECCC has provided responses to these questions with regards to the key priorities under "Healthy Environment Relationships" in Table 3, including:

- Climate change adaptation (including change in species, reflected in the wildlife and wildlife habitat category);
- Water and river systems, including flows;
- Peatlands and other unique environments (including from a carbon storage, wildlife habitat and ecological function, and hydrology lens);
- Wildlife and wildlife habitat, including species at risk, migratory birds, and fish and fish habitat;
- Forest ecosystems, including plants (reflected throughout the wildlife and wildlife habitat category); and
- Biodiversity (reflected throughout the wildlife and wildlife habitat category).

Climate change adaptation:

ECCC does not have responses for (a) – (c) for this topic at this time.

d) known data gaps or uncertainties:

Net contributions to climate change: Projects within the Ring of Fire (RoF) area would likely generate greenhouse gas (GHG) emissions during the construction, operations and decommissioning phases, and may have operations (and thus contributions) beyond 2050. Projects may have the potential to contribute to Canada's climate change commitments in the long term if the products or infrastructure directly advance the green economy or critical mineral supply chain, and if the products are used to displace higher-emitting products or enable cleaner technology.

e) suggestions for studies or other ways to fill those gaps:

The Strategic Assessment of Climate Change (SACC) should be referenced as the best practices for the evaluation of GHG emissions, impacts on carbon sinks, impact on federal emissions reduction efforts and global GHG emissions, GHG mitigation measures, including Best Available Technologies/Best Available Practices, climate change resilience, considerations for assessing upstream GHG emissions and developing a credible plan for achieving net-zero GHG emissions by 2050.

Water and river systems, including flow:

a) the best sources of existing data, including means to access it,
Relevant data associated with water and river systems, including flow, include:

- hydrometric data (flows and water levels) in the receiving environment,
- associated drainage basin polygons, and
- operational data (water withdrawals and/or discharges to the receiving environment) from ongoing or planned operations within the RoF area.

Hydrometric data collected by ECCC is available to the public online (https://wateroffice.ec.gc.ca/) and provisional data is available online for web-scraping in the "Data Mart" section. A preliminary release of drainage basin polygons associated with monitoring stations is also available through the same website. Additional hydrometric monitoring data may be available from privately owned and operated stations. Hydrometric and operational data from private owners and operators may be reported as part of federal or provincial authorizations or permits. Provincial permits regulating withdrawal and discharges, such as Permit to Take Water and Environmental Compliance Approval, are accessible via the Ontario Ministry of the Environment, Conservation and Parks' Access Environment tool for existing operations. Additional data may be available and could be requested directly from the relevant authorities and private owners. Reports submitted under the Environmental Compliance Approvals and existing projects that have gone through or are actively going through the *Canadian Environmental Assessment Act*/*Impact Assessment Act* process in the assessment area may also have water quality data. For example, the Victor Diamond Mine Project may have existing baseline studies and analyses related to water quality as part of the Environmental Assessment and Follow-up Program. Additionally, the Marten Falls Community Access Road, Northern Road Link, and Webequie Supply Road Projects may have baseline study data already completed (or in progress).

b) <u>adequate spatial and temporal boundaries to assess impacts,</u>

The spatial and temporal boundaries for assessing the potential effects from past, existing, and future development on the river systems hydrology in the RoF area would be valued component-dependant and should consider other assessment priorities and valued components. The spatial boundary should allow for the characterization of the hydrologic regime of the river systems within the assessment area. It is worth noting that cumulative effect assessments may be required to understand the potential impacts that generalized development in the area may have on a river system. The temporal scale needs to be fine enough to capture changes during critical periods (e.g., seasonal high and low flow periods) and long enough to capture interannual trends. Overall, watershed spatial scales and temporal scales from decadal to seasonal would be relevant in the context of the RoF region.

c) <u>key indicators to describe potential impacts,</u>

Key indicators to assess potential impacts are changes to flows and/or water levels, specifically during critical periods (e.g., seasonal high and low flow periods). Examples of key indicators include changes to baseflow, low flow (e.g., 7Q20) or flood events.

d) <u>known data gaps or uncertainties,</u>

Related to data collection:

Measured flow and/or water level data have inherent uncertainty related to the collection and analytical methods used. Common sources of uncertainty include the precision of monitoring equipment, accuracy of field collection methods, challenges collecting data during certain conditions (e.g., ice-cover period, low flows, high flows), limitation of data to selected monitoring stations, and accuracy of rating curves used to convert water levels in flows, specifically to interpret levels under low- or high-flow conditions. For example, ECCC hydrometric sites are limited in the RoF region (five sites operated in partnership with Water Survey Ontario), which may mean that the operating water budgets for mine sites proposed in the future in the region (e.g., for tailings ponds) and effect assessments to water quantity will need to be extrapolated from existing data with a high level of prediction uncertainty.

Regional data gaps:

While the resources listed above provide general information on hydrologically vulnerable areas in the RoF region, ECCC notes that studies evaluating how or to what degree peatland loss in specific watersheds may manifest in changes to water resources are lacking. Resource extraction developments generally cause a loss (or gain) in hydrological connectivity and runoff pathways among individual peatlands, thus changing water availability and chemistry downstream. More understanding of the impacts of resource development, in addition to the contribution of discharge from mines (for example) on hydrology is needed.

e) <u>suggestions for studies or other ways to fill those gaps.</u>

There is a wide range of procedures and type of studies that can address data gaps related to water and river systems, specifically to address missing data, to extend records, or to estimate hydrometric data at target locations different than those monitored. The most suitable method depends on the target locations and the quantity, quality and hydrological similarity between target locations and monitored watersheds. Some of the methods to fill missing records or extend the monitoring period at a target location include transposition of flow data from hydrologically similar watersheds, flow duration curves, maintenance of variance extension (MOVE.1) or equivalent method, and as needed, several variations of routing methods to regulate or naturalize flows. Today, hydrologic modelling is a common approach to fill systemic gaps and to evaluate potential impacts to river systems. These models rely on hydrometric monitoring data for calibration and validation. Hydrologic models can be adjusted to incorporate the predicted effects of planned or potential projects in the basin such as changes in drainage patterns, water withdrawals, discharges, changes to land cover affecting the runoff coefficient, or changes to climate. Generally, water level predictions require alternative tools such as hydraulic models or hydraulic routing, and require additional data such as channel morphology, bathymetry, and hydraulic structures. Additionally, ECCC suggests the calculation of historical seasonal water budgets at the 100 km^2 watershed scale for the RoF region using ERA-5 (ERA5 hourly data on single levels from 1940 to present).

Peatlands and other unique environments

Carbon Storage:

ECCC does not have responses for (a) – (b) for this topic.

c) key indicators to describe potential impacts,
When considering effects to peatlands related to carbon storage, the Strategic Assessment of Climate Change (SACC) Technical Guide should be referenced as the best practices for the evaluation of impacts on carbon sinks, including assessment methodology and key indicators.

d) known data gaps or uncertainties,
With regards to carbon storage, peatlands, swamps and fens can be carbon sources or sinks and so projects may result in a positive or negative impact on carbon sequestration. Impacts to these receptors are highly site-specific, dependent on the vegetation, soil, minerology and terrain of the area, with a high level of uncertainty. Additionally, the SACC Technical Guide details the methodologies and uncertainties when estimating the natural carbon sink capacity of lands.

e) suggestions for studies or other ways to fill those gaps.
The SACC and associated Technical Guide should be referenced as the best practices for the evaluation of impacts on carbon sinks such as peatlands, including methodology. Depending on the amount of hectares of carbon sinks being impacted, either default values can be used, or detailed, site-specific flux values from field studies or accurate studies from the same location as the project would be required.

Hydrology:

a) the best sources of existing data, including means to access it,
Project-specific wetland characterization studies within the RoF area include the Webequie Supply Road and Marten Falls Community Access Road. Both studies contain field collected data that describe local existing conditions and provide a more detailed overview of peatland hydrology for the areas studied.

Additionally, ECCC recommends the following data sources and references:

- Canadian Wetland Inventory Map Canadian Wetland Inventory Map Version 3A (CWIM3A) - Open Government Portal
- Ontario GIS datasets available through the Ontario GeoHub portal: Wetland (Wetland | Ontario GeoHub)
- Boreal-Arctic Wetland and Lake database (as described in Olefeldt et al., 2021)

- Arctic Circumpolar Distribution and Soil Carbon of Thermokarst Landscapes - includes the Hudson Bay lowlands (https://www.earthdata.nasa.gov/data/catalog/ornl-cloud-thermokarst-circumpolar-map-1332-1) as described in Olefeldt et al., 2016
- Peat-ML (GMD - A map of global peatland extent created using machine learning (Peat-ML)).
- Aerial photographs, generally
- Lidar data, generally.

b) adequate spatial and temporal boundaries to assess impacts,

The spatial and temporal boundaries for assessing the potential hydrological effects from past, existing and future development on peatlands and other unique environments in the RoF would be valued component-dependant and should consider other assessment priorities and valued components, and should be consistent with the recommendation provided above for water and river systems. The temporal scale should be fine enough to allow for identification of alterations in wetland hydroperiod (the length of time and time of the year that a wetland holds water). To achieve this, the temporal scale of baseline characterization studies should be long enough to be able to capture seasonal and interannual trends in wetland hydroperiod, and surface and groundwater movement.

c) key indicators to describe potential impacts,

Initial wetland mapping assessments should be complemented with field assessments to allow for confirmation of wetland distribution and gather data required to describe the wetland's hydrological regime (hydrological pathways and water budget). Field assessments inform baseline wetland characterization and allow for identification of expected project effects; however, selection of indicators for project related effects in wetland environments can be difficult. The combination of different wetland environments and specific project effects can cause alterations to different parts of the hydrological regime resulting in different response magnitude or even different effects. As such, indicator selection should be done on a project-by-project basis taking into consideration the specific wetland environment the project sits on, and its expected effects.

From the perspective of impacts to water resources in peatlands in the discontinuous permafrost zone of Northern Ontario, ECCC recommends review of the Canadian Water Resource Vulnerability Index to Permafrost Thaw ($CWRVI_{PT}$) as described in Spence et al., 2020 with maps found at: Canadian Water Resources Vulnerability Index - Permafrost Loss - Open Government Portal

d) known data gaps or uncertainties,

The hydrologic regime of a wetland can be very complex due to the dynamic relation between surface water and groundwater interaction. This dynamic relationship makes wetlands difficult ecosystems to classify, quantify and evaluate. Wetland characterization field studies carry a level of uncertainty, and it is important that this uncertainty is well understood and quantified. Estimation of potential effects from a project or activity will carry forward any uncertainty from the wetland characterization used to estimate effects.

e) suggestions for studies or other ways to fill those gaps.

ECCC suggests conducting studies such as those by Olefeldt et al., 2021, 2016 and Spence et al., 2020 with a focus on the RoF area and with higher resolution data. These studies could assist in understanding impacts to water resources, including the extent of impacts with peatland disturbance.

Given the inherent uncertainty in wetland characterization, it is important for monitoring programs and adaptive management practices to be in place as projects are designed and operated. Ongoing monitoring during project construction and operation allows for confirmation of initial assumptions or estimation of potential effects and also allows for mitigation measures to be refined or added as needed.

Wildlife Habitat & Ecological Function:

a) the best sources of existing data, including means to access it,

Canadian National Wetlands Inventory:

The Canadian National Wetlands Inventory (CNWI) is a comprehensive, publicly available national geodatabase developed by ECCC, in collaboration with federal, provincial, and territorial governments, academia, Indigenous groups, and Non-Governmental Organizations (NGOs). It consists of the best available wetland mapping data, along with its metadata, published in a standardized manner.

https://open.canada.ca/data/en/dataset/d5af4ac5-ebdb-4645-bb0a-8ec5cac5e29f

Wetland Mitigations Bibliography:

A compilation of information including reports and scientific studies, particularly as they relate to mitigating impacts on wetlands, was compiled by a contractor of ECCC and is publicly available at the link below. Viewing through the Zotero application will allow the user to filter resources based on topic tags assigned by the library's host.

https://www.zotero.org/groups/5814951/wetland_mitigation_options_bibliography

Other ECCC Data:

ECCC also has products for the Hudson Plains ecozone, available upon request, including ecosystem and wetland mapping, peat depth/carbon and vegetation biodiversity mapping, and comprehensive and standardized disturbance mapping for the boreal forest.

b) adequate spatial and temporal boundaries to assess impacts,

To assess impacts to peatlands or wetlands within future impact assessments:

- local study areas should take into account watershed area and hydrological connectively of wetlands within, or bisected by, the project area;
- regional study areas should be of sufficient size to capture effects to wetlands within the larger drainage area and include wetlands located outside of the local study area that may be affected by hydrological changes as a result of cumulative effects.

c) key indicators to describe potential impacts,

Wetland ecological function assessments and monitoring programs provide a way to quantify specific ecological functions of a wetland and use these functions as indicators of project-related effects. These assessments are categorized using a three-tier system based on the intensity and scale of assessment (Hanson et al., 2008). These range from broad, landscape scale assessments (known as Level 1 methods), to rapid field methods (Level 2), to intensive biological and physical-chemical studies (Level 3).

Some potential indicators that could be useful to describe potential impacts to peatlands and wetlands, particularly in their function as habitat for wildlife including migratory birds and species at risk, include but are not limited to:

- Landscape disturbance, including loss and fragmentation of habitats;
- Area of vegetation communities;
- Interior to edge habitat ratios;
- Availability of rare habitat;
- Habitat functions;

- Prevalence of weed species or invasive species; and
- Hydrological or water flow changes.

Furthermore, ECCC is working on some time-series products, including a detailed analysis of the Victor Diamond Mine Project site, to reveal more information about the scale at which the impacts need to be considered, as well as indicators that could be used, such as drying or browning of vegetation due to a development in the Hudson Bay Lowlands peat rich environment. More information can be provided upon request from the Regional Assessment Working Group (RAWG).

ECCC does not have responses for (d) – (e) for this topic.

References:

Hanson, A., L. Swanson, D. Ewing, G. Grabas, S. Meyer, L. Ross, M. Watmough, and J. Kirkby. 2008. Wetland Ecological Functions Assessment: An Overview of Approaches. Canadian Wildlife Service Technical Report Series No. 497. Atlantic Region. 59 pp.

Olefeldt et al., 2016: Circumpolar distribution and carbon storage of thermokarst landscapes. Nature Communications, 7, 130143, doi: 10.1038/ncomms13043.

Olefeldt et al., 2021: The Boreal–Arctic Wetland and Lake Dataset (BAWLD), Earth Syst. Sci. Data, 13, 5127–5149 (https://doi.org/10.5194/essd-13-5127-2021).

Spence et al., 2020. The Canadian Water Resource Vulnerability Index to Permafrost Thaw (CWRVIPT). Arctic Science 6: 437–462 (2020) dx.doi.org/10.1139/as-2019-0028.

Wildlife and wildlife habitat, including species at risk, migratory birds, and fish and fish habitat:

NOTE: Responsibility for wildlife conservation in Canada is shared between the federal, provincial, and territorial governments. The *Species at Risk Act* (SARA) was designed to work collaboratively with provincial and territorial legislation to protect species at risk. Under SARA, the federal government is responsible for migratory birds and aquatic species at risk wherever they occur, as well as terrestrial species at risk found on federal lands. Under these conditions, certain SARA prohibitions protecting individuals and residences (e.g., nests or dens) of endangered, threatened and extirpated species apply automatically.

ECCC is committed to working collaboratively with the provinces and territories on the recovery and conservation of species at risk including Boreal Caribou. ECCC regularly meets with Ontario's Ministry of the Environment, Conservation, and Parks to discuss and collaborate on shared interests including the protection and recovery of species at risk and their habitat in Ontario as it relates to federally listed terrestrial species at risk.

General:

ECCC holds expertise on species at risk and migratory birds and their habitats, which may include forests, peatlands, and other ecosystems. As such, this information may also apply under other priority topics. This section answers questions (a) – (e) for species at risk and migratory birds generally, then adds additional details for specific species or species groups where possible. ECCC has also included answers to (a) – (e) with regards to contamination in wildlife, based on "lessons learned" from over a decade of monitoring in the boreal region of Northern Alberta. This is below the responses for individual species (i.e., caribou and polar bear).

a) the best sources of existing data, including means to access it,

ECCC can offer expertise on Boreal Caribou, Eastern Migratory Caribou, migratory birds, and other species at risk and their habitats in the Ring of Fire assessment area. Generally, this area has regional biodiversity data gaps, including low spatial coverage, spatial gaps, and temporal gaps. Since 2020, ECCC has been working to help fill knowledge gaps in the Ring of Fire region related to the conservation of migratory birds, the recovery of species at risk, and the protection of nationally-important wildlife habitat. ECCC holds data from ongoing wildlife surveys, including acoustic data, and experts are working to analyze this information to model distribution, abundance and habitat associations of caribou and migratory birds. These analyses will inform cumulative effects modelling and support development of tools to support the understanding of potential impacts of development and mitigation options.

A table of ECCC Datasets Within Assessment Area was provided as part of the March 2025 ECCC FAAR Response – Wildlife Datasets Within Assessment Area (pages 32-37). There are no new datasets to add since that time, but the table has been updated to include an additional column indicating means to access each dataset (Attachment IV).

ECCC has developed a national connectivity map that highlights areas important for connectivity for species that tend to avoid human-dominated or disturbed land cover. The connectivity map can be used to determine if the project proposal falls within an area important for connectivity at a regional scale. The map (Current_Density_2_Resistance.tif), has a resolution of 300 x 300 metres and is available for download via the Open Science Framework: (https://osf.io/z2qs3/files).

Datasets hosted in government portals (public access):

The Canadian National Wetlands Inventory (CNWI) is a comprehensive, publicly available national geodatabase developed by ECCC in collaboration with federal, provincial, and territorial governments, academia, Indigenous groups, and Non-Governmental Organizations (NGOs). It consists of the best available wetland mapping data, along with its metadata, published in a standardized manner. https://open.canada.ca/data/en/dataset/d5af4ac5-ebdb-4645-bb0a-8ec5cac5e29f

The Trends in Canada's bird populations indicator reports population trends of Canada's native bird species from 1970 to 2022. Bird species are categorized into species groups based on their feeding or habitat requirements. https://open.canada.ca/data/en/dataset/766a71ce-d798-49e2-bee2-7ec65c7c5d56

Trend results are also available by Bird Conservation Region from the Breeding Bird Survey, and similarly provide data from 1970 to 2022: https://wildlife-species.canada.ca/breeding-bird-survey-results/P001/A001/?lang=e

More information on the following datasets are provided in the March 2025 ECCC FAAR Response:

- Critical Habitat for Species at Risk National Dataset – Canada - https://open.canada.ca/data/en/dataset/47caa405-be2b-4e9e-8f53-c478ade2ca74
- Species at Risk Public Registry - https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.htm
- Canadian Protected and Conserved Areas Database (CPCAD) - https://open.canada.ca/data/en/dataset/6c343726-1e92-451a-876a-76e17d398a1c

Publicly available data sources

- Global Biodiversity Information Facility - https://www.gbif.org/
- NatureCounts data (hosted by Birds Canada) can be accessed online at https://naturecounts.ca/nc/default/explore.jsp or through R;
    - User guides are available to guide data access: https://learn.birdscanada.org/additional-resources/naturecounts/
- Wildtrax data (hosted by Alberta Biodiversity Monitoring Institute and the Bioacoustics Unit and the University of Alberta) can be accessed online at https://portal.wildtrax.ca/discover
    - Online tutorials describing the platform and data access is available: https://wildtrax.ca/resources/tutorials/page/2/

- Natural Heritage Information Centre (NHIC; hosted by the Government of Ontario) can be accessed online and provides information on the locations of species of conservation concern;
  - https://www.lioapplications.lrc.gov.on.ca/Natural_Heritage/index.html?viewer=Natural_Heritage.Natural_Heritage&locale=en-CA
  - Questions or requests related to NHIC information should be directed to the Province of Ontario;
- iNaturalist - https://www.inaturalist.org/
  - including NHIC project for rare species - https://inaturalist.ca/projects/nhic-rare-species-of-ontario

b) adequate spatial and temporal boundaries to assess impacts,

Note that the following information and considerations are adapted from the recommendations provided by ECCC as part of the 2023 ECCC FAAR response, on pages 17-19.
Adequate geographic and temporal boundaries to assess impacts will vary depending on the wildlife species and habitat types being considered, and the development activities being scoped into the assessment. Upon request, ECCC may be able to provide more detailed advice on appropriate spatial and temporal boundaries to assess impacts once specific species at risk or migratory birds of interest are identified by the RAWG and information on potential development activities and timing are provided. In the interim ECCC offers the following considerations driven by ECCC's mandate to consider migratory birds, species at risk, and their habitats.

General Considerations

- It is understood that geographic boundaries relevant to assessment priorities, including individual species, species groups, or habitat types can be a subset of the total spatial scope of the Regional Assessment (RA).
- These boundaries should vary based on the species, species group, or habitat type of interest while taking into account the mechanisms by which potential development may impact species and life cycle and habitats of the species of interest.
- Relevant geographical boundaries may also need to vary depending on the exact impacts or potential activities being assessed.

Spatial and temporal boundaries should be defined such that the extent of the boundaries reflect the ways in which potential development is anticipated to impact the species. Application of this principle will likely result in different boundaries for different groups or species. For example, different spatial boundaries might be needed for wolverine, where winter home ranges in Ontario average > 2000 km^2 for males and > 400 km^2 for females (Dawson et al. 2010) compared to Yellow-banded Bumble Bee, which may disperse up to 10 km from their colony of origin based on studies on other bee species (e.g. Kraus et al. 2008, Lepais et al. 2010). Upon request, ECCC may be able to provide additional expertise on specific migratory bird or species at risk.

c) key indicators to describe potential impacts,

Indicators should differ based on the types of disturbances or activities causing potential impacts. Indicators should also differ depending on the wildlife species, species groups, or habitat of focus. Upon request, ECCC may be able to provide more specific recommendations on key indicators for assessing potential impacts once species and/or development activities of interest are specified by the RAWG.

d) known data gaps or uncertainties,

Data availability for wildlife in northern Ontario, including in much of the assessment area, is generally sparse, especially compared to the vast area of this region. This is related to relatively low survey effort that has often been opportunistic rather than systematic in design. This problem is exacerbated for species that are rare or sparsely distributed, as is common for species at risk (SAR). As such, it is uncertain whether all species at risk or migratory birds that are present in assessment or development areas have yet been reported to public databases. For those SAR that have been observed, often little is known about distribution, range limits, population sizes and trends, or habitat associations, and information that is available may have low reliability due to limited sample sizes.

ECCC surveys in the region (overview provided as part of the March 2025 ECCC FAAR response) provide valuable new data to improve the availability of information on wildlife in the region. However, survey coverage remains sparse relative to the vast area and not all taxa are addressed equally. Information on arthropods, reptiles and vascular plants is particularly limited for the region.

e) suggestions for studies or other ways to fill those gaps.

Given the limited data availability on wildlife across the region, further information gathering efforts across a range of taxa would be beneficial to address knowledge gaps in the assessment area. Studies that address multiple species or multiple taxa within the same study design can help improve efficiency in surveying the vast spatial extent of the assessment area, though species-specific or other targeted surveys may be required in some instances. Wherever possible, surveys should be designed to survey habitats systematically rather than opportunistically, and to fill known spatial, taxonomic, or temporal gaps in existing data.

Some general suggestions and considerations for specific species or species groups are provided below. The information provided below is general in nature and may need to be further tailored based on the specific disturbances or activities being considered. For known data gaps and uncertainties, this is not an exhaustive list of knowledge gaps on wildlife and wildlife habitat in the region. An extensive literature review would be required for each species to understand the complete status of knowledge and all associated knowledge gaps for each individual species. In line with knowledge gaps outlined in 2d, some suggestions for studies are provided below. Many of the studies are likely to be challenging and contingent on available resources and collaborative partnerships.

Pollinators:

d) known data gaps or uncertainties,

Knowledge gaps for bumble bees and for pollinators more broadly in northern Ontario include:

- Species distribution;
- Population trends; and
- The potential importance of known threats to bumble bees (including habitat loss, pesticide use, climate change and pathogens and parasites linked to managed bees) in Ontario's Far North.

e) suggestions for studies or other ways to fill those gaps.

Further surveys are needed in Ontario's Far North to improve basic understanding of the distribution of all pollinator species including species at risk bumble bees, as well as to fill knowledge gaps on habitat requirements and threats in this region. Using a variety of survey methods throughout the active season will improve the chance of capturing rare species.

Bats:

d) <u>known data gaps or uncertainties,</u>

In 2021-2022, ECCC contracted the Toronto Zoo to write a report on the status of knowledge of bats in Ontario's Far North, including identification and prioritization of knowledge gaps. The full report has been included with this response to provide background information on bats in the region (Attachment VI). Note that at the time of this report, acoustic monitoring data collected by ECCC had not yet been analyzed and eastern red bat, hoary bat, and silver-haired bat COSEWIC (Committee on the Status of Endangered Wildlife in Canada) assessments had not yet been completed.
Some high priority knowledge gaps as recommended by experts from the Toronto Zoo include:

- Limited data availability across Ontario's Far North;
- Gaps in baseline understanding of existing populations;
    - Sub-regional population demographics and trends;
    - Hibernacula locations;
    - Maternity roost locations for some species;
- Gaps in understanding of species' habitat requirements;
    - Landscape scale maternity habitat characteristics and distribution;
    - Landscape scale hibernation habitat characteristics and distribution;
    - Local scale maternity habitat distribution for some species;
- Gaps in understanding of anticipated threats to bats in the region;
    - Spread and impact of white-nose syndrome; and
    - Resiliency to habitat degradation.

e) <u>suggestions for studies or other ways to fill those gaps.</u>

In the report (Attachment VI), the expert-provided summary of knowledge report reviewed 17 potential approaches and ranks them in order of anticipated value (knowledge gaps addressed), and practicality of implementation. Some high value, easy to implement studies include long-term acoustic studies and local trap and release studies. Studies that may be more difficult to implement but would still yield high value for addressing knowledge gaps includes radio-telemetry studies of migratory species and roost box monitoring.

Migratory Birds:

c) <u>key indicators to describe potential impacts,</u>

Recommended indicators for migratory birds may differ depending on species and the potential impacts that are being assessed. For most birds, basic information is limited, and as such, useful indicators may include measures of:

- Seasonal abundance including counts during migration periods, and relative abundance in each habitat type;
- Breeding distribution and density of breeding pairs, including relative abundance of breeding pairs in each habitat type;
- Occupancy and habitat associations;
- Changes to short- and long-term habitat availability; and
- Changes to mortality risk.

d) known data gaps or uncertainties,

Prior to 2021, when ECCC surveys were initiated, most data for breeding birds in Ontario's remote North were about 20 years old (e.g. from the Ontario Breeding Bird Atlas 2, https://www.birdsontario.org/atlas-2/, collected in 2001-2005), with most of the samples located in the habitat types adjacent to and near the major navigable rivers at locations accessible by canoe and collected using a single-visit point count. Since 2021, ECCC has conducted bird surveys in portions of the assessment area and in adjacent areas and watersheds.

Below, some knowledge gaps and uncertainties are identified by groups of birds. Addressing these knowledge gaps would improve the reliability of conclusions about baseline conditions, enhance understanding and forecasts of pathways of effects, support predictions of responses by birds and their habitats, and would contribute to species assessments and SAR bird listing and recovery.

Waterfowl (e.g. ducks, geese, swans)

- Data on later-nesting waterfowl species (e.g., diving ducks: Ring-necked Duck, Lesser Scaup and Greater Scaup, and sea ducks: Common Goldeneye, Bufflehead, White-winged Scoter, Surf Scoter and Black Scoter) such as species abundance, breeding pair abundance, distribution, habitat use/associations and seasonal timing, and migration/movement patterns;
- Waterfowl breeding productivity (brood surveys);
- Post-breeding season habitat use/associations of brood flocks, non-breeders/failed-breeders and moulting males and females;
- Information on species abundance and distribution, migration timing/movements, and habitat use/associations during spring and fall; and
- Pre-development and post-development data for waterfowl inland from the James Bay coastline within the Hudson Bay Lowlands and Boreal Forest habitats such as abundance, breeding pair abundance, distribution, habitat use/associations and migration timing/seasonal movements.

Waterbirds (e.g., gulls, terns, herons)

- Pre- and post-development information on waterbird breeding distribution; and
- Abundance and habitat associations of aquatic birds and wetland-dependent birds.

Shorebirds (e.g. plovers, sandpipers)

- Degree and timing of dependence of several shorebird species on wetland and associated habitats for migration stopover/refueling;
- Shorebird breeding productivity (nest success, recruitment, survival);
- Quantity of shorebird breeding and migration habitat in the assessment area;
- Lesser Yellowlegs and Short-billed Dowitcher breeding distribution, abundance, density, and within the assessment area; and
- Lesser Yellowlegs and Short-billed Dowitcher habitat use within the assessment area (home range size, local and long-range movements, arrival/departure decisions at pre and post breeding).

Landbirds (e.g. forest birds, birds of prey, aerial insectivores)

- The degree and timing of migratory bird reliance, for migration stopovers and breeding, on upland esker habitat types, which are an uncommon landscape feature in the assessment area; and
- Relative importance to national populations for several bird species detected in the assessment area. This uncertainty stems from recent evidence suggesting that several species, some of high conservation concern, are more widespread and/or more abundant in the assessment area than had

previously been understood (e.g., Lincoln Sparrow, Connecticut Warbler, Olive-sided Flycatcher, Common Nighthawk).

e) <u>suggestions for studies or other ways to fill those gaps.</u>

Waterfowl (e.g. Ducks, geese, swans)

- Conduct aerial surveys inland from the James Bay coastline in the boreal forest and Hudson Bay Lowland habitats to get up-to-date baseline information on abundance, distribution and habitat use/associations of waterfowl during various seasons, particularly during the breeding (as well as spring and fall migration) period; and
- Deploy satellite or GPS/GSM transmitters on species to obtain detailed information on seasonal habitat use, timing of movements/migration and migration/movement pathways or corridors; deployments could be focused on species that are highly valued for cultural significance or food (e.g., geese or ducks) by First Nations or for those identified as lacking basic ecological information in Ontario's Far North or other parts of North America (e.g., late-nesting diving duck and sea duck species, American Black Ducks, Sandhill Cranes).

Waterbirds (e.g., gulls, terns, herons)

- Conduct surveys targeted specifically at colony-nesting waterbirds (habitats covered and survey timing would differ from surveys optimized for waterfowl);
- Use existing information from waterfowl surveys, autonomous recording unit (ARU) deployments and the Ontario Breeding Bird Atlas (Atlas-3) to gain insights on current waterbird species distributions;
- Habitat association models for these species in northwestern Ontario could support description of important habitat characteristics and the potential distribution of habitat in the assessment area;
- Tracking studies (GPS tags) of Bonaparte's Gull and Common Tern would inform habitat use and breeding site fidelity within the assessment region (an important breeding area for both of these species); and
- ARU studies have the potential to provide information on the breeding distribution (and possibly relative abundance) of wetland-dependent birds.

Shorebirds(e.g. plovers, sandpipers)

- Tracking studies (GPS tags) of breeding Lesser Yellowlegs and Short-billed Dowitcher could inform habitat use within the assessment area, timing and dependence on wetland and associated habitats during breeding and post-breeding, and arrival and departure decisions related to migration timing;
- Studies modelled after the Arctic Shorebird Demographics Network methods (https://www.manomet.org/wp-content/uploads/old-files/ASDN_Protocol_V5_20Apr2014.pdf) could inform productivity metrics for several shorebird species breeding in the assessment area; and
- Desktop GIS analysis to determine quantities of shorebird breeding (coastal saltmarsh and beach, tundra, and taiga) and migration (intratidal flats and marsh, and supratidal zone) habitat available in the assessment area. The products of this analysis could inform the minimum amount of available breeding and migration habitats in the assessment area that must be sustained to maintain and improve shorebird abundance.

Landbirds (e.g. forest birds, aerial insectivores)

- Continue to conduct ARU-based sampling of the landbird community, targeting priority gaps in spatial coverage, including the eastern (downstream) extents of the James Bay Lowlands ecoregion. An appropriate aim would be to achieve sampling coverage sufficient to infer species occurrence across the Hudson Bay Lowlands portion of the assessment area;

- Conduct detailed surveys (i.e. acoustic surveys, point counts, etc.), during both breeding and migration periods, targeting bird use, species composition, timing and abundance patterns of upland esker habitats to support modeling and other analyses concerning linear development impacts; and
- Conduct analysis to distinguish seasonal patterns and habitat associations of species breeding in the assessment area from those using the area during migration.

Caribou:

a) the best sources of existing data, including means to access it,

ECCC is in the final stages of developing a genetic database for Boreal Caribou and Eastern Migratory Caribou in Ontario (includes RoF region and more southern ranges) which will provide comprehensive baseline information on the distribution of the two ecotypes, their connectivity across the region and genetic diversity (see Project #2 in Attachment I).

b) adequate spatial and temporal boundaries to assess impacts,

Spatial Boundaries

Two ecotypes of caribou occur in the assessment area, Boreal Caribou and Eastern Migratory Caribou. These ecotypes overlap during winter, when most surveys occur. Boreal Caribou and Eastern Migratory Caribou cannot be visually distinguished from one another (Couturier et al. 2010), and winter aerial survey results from northern Ontario provincial Boreal Caribou ranges that overlap with the Eastern Migratory Caribou range include both ecotypes of caribou. Furthermore, genome-wide analysis revealed low genetic differentiation between the two ecotypes, and a high level of mixture in the RoF region (See Project 2 in Attachment I). See Caribou section of Attachment III (response to #8) for additional information about the two caribou ecotypes. Due to differences in seasonal movement patterns, separate spatial boundaries are suggested below for each caribou ecotype.

Boreal Caribou

- Boreal Caribou occur in the assessment area year-round, are generally widespread in the assessment area and move over large distances to complete their lifecycle.
- Boreal Caribou are managed using ranges, defined in federal and provincial recovery documents (MNRF 2014a; ECCC 2020). Provincial Boreal Caribou range boundaries were delineated by the province of Ontario primarily for logistical purposes (i.e., to select an area of reasonable size to survey) based on animal movement data, spatial extent, and other factors (MNRF 2014a). Boreal Caribou have been recorded to move across range boundaries at times.
    - The assessment area overlaps the borders of eight Boreal Caribou provincial ranges: Missisa, Ozhiski, James Bay, Nipigon, Pagwachuan, and smaller portions of Kesagami, Brightsand and Kinloch.
    - The assessment area overlaps the borders of five federal ranges: Far North, Kesagami, Pagwachuan, Nipigon, and Brightsand (Figure 1).
- However, genetic results from Trent University and ECCC (see Project #2 in Attachment I) indicate that Boreal Caribou in Ontario are not found in discrete local populations. As such, ECCC recommends the full extent of the following five ranges should be considered as a minimum for the spatial extent for the Boreal Caribou under the RA (Figure 1): Missisa, Ozhiski, Nipigon, Pagwachuan and James Bay.

Eastern Migratory Caribou

- The Eastern Migratory Caribou in Ontario form part of the Southern Hudson Bay Eastern Migratory Caribou subpopulation, which extends from Cape Henrietta Maria west across the Ontario-Manitoba border (Figure 1, COSEWIC 2017).
- Within this subpopulation, Eastern Migratory Caribou spend the winter inland, and move to the Hudson Bay coast for the summer, where they calve (Figure 1).
- Eastern Migratory Caribou rely directly or indirectly on the entire range to complete their lifecycle (COSEWIC 2017). There is no recognized ecological subdivision of the Southern Hudson Bay subpopulation suitable for the purposes of the RA.
- Therefore, ECCC recommends that the range of the Southern Hudson Bay subpopulation of Eastern Migratory Caribou be used as the spatial extent for Eastern Migratory Caribou under the RA (Figure 1).

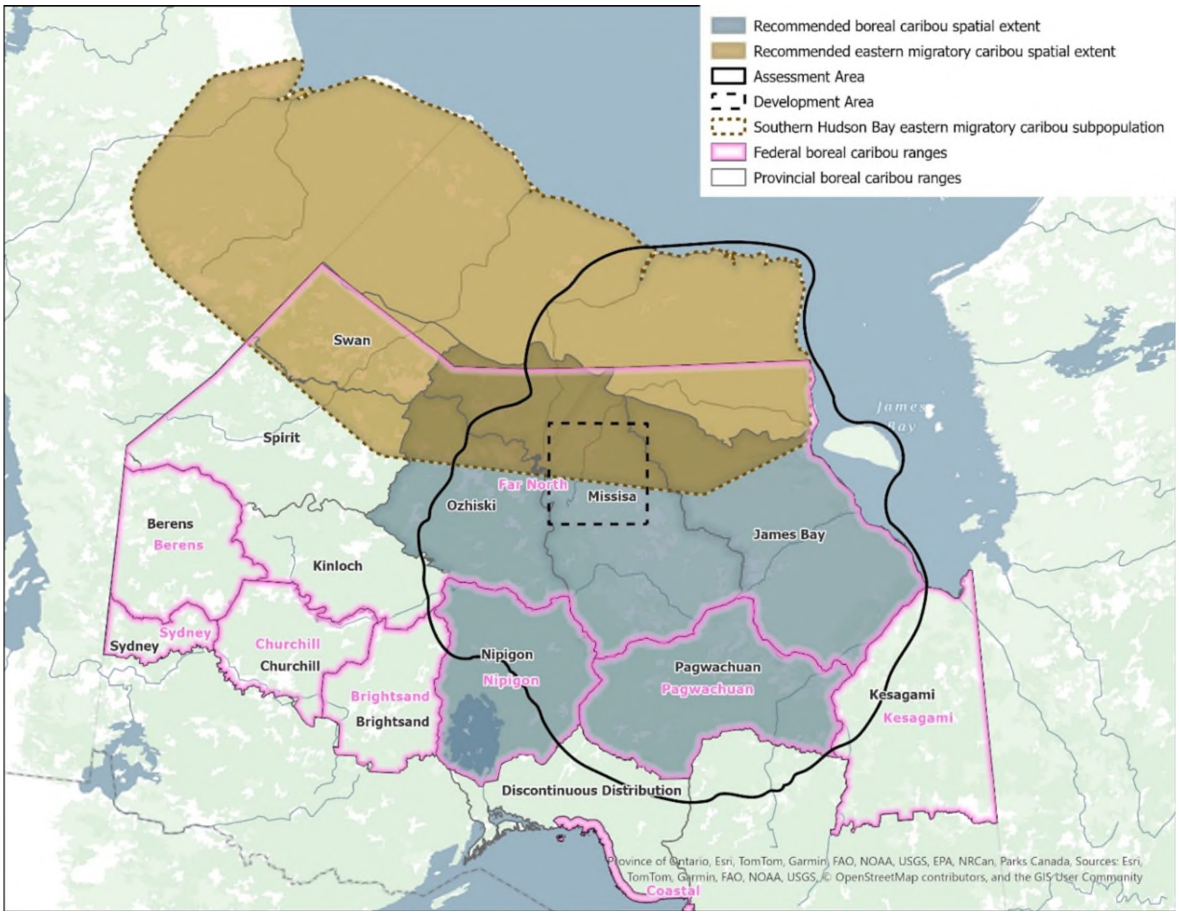


Figure 1. Federal and provincial ranges of Boreal Caribou and Eastern Migratory Caribou in the assessment and development areas as specified in the Terms of Reference for the Ring of Fire Regional Assessment. Shaded regions represent recommended Boreal Caribou and Eastern Migratory Caribou spatial extents for the Regional Assessment.

Temporal Considerations

The impacts of threats to Boreal Caribou and Eastern Migratory Caribou populations have a lag effect, which can take years to manifest (Vors et al. 2007). Population data needs to be collected over an extended period of time to ensure the lag effects of disturbance on a local population have been considered and accounted for (ECCC 2020). Measurable effects on caribou may take years, if not decades, to become apparent, and long-term monitoring programs are needed to evaluate outcomes and guide adaptive management (https://abmi.ca/abmi-home/working-together/projects-collaborations/caribou-habitat-restoration-monitoring). Below, some considerations for temporal monitoring of caribou are provided.

Boreal Caribou
A minimum of three years of telemetry monitoring is required to obtain current estimates of caribou survival, recruitment, and a population trend. In general, to obtain long-term population trend data, data from a minimum of three generations of caribou, or approximately 20 years is needed (ECCC 2020).

Eastern Migratory Caribou
Populations of migratory caribou, such as Eastern Migratory Caribou, can fluctuate in abundance over decades (Gunn 2003; Bergerud et al. 2008; Festa-Bianchet et al. 2011). Studies on the Southern Hudson Bay subpopulation showed a lag between peak caribou abundance and vegetation recovery of approximately six years due to delayed effects of both herbivory and vegetation recovery (Newton et al. 2014). Southern Hudson Bay caribou displayed a pronounced local change in summer distribution over three decades, corresponding in part to anthropogenic disturbance (Magoun et al. 2005; Abraham et al. 2012; Berglund et al. 2014; Newton et al. 2015).
Similar to Boreal Caribou, long-term population monitoring is likely to need a minimum of three generations of data, and should be undertaken at a spatial scale appropriate to encompass factors such as long-term shifts in calving and wintering areas (Taillon et al. 2012) as well as large changes in abundance (Bergerud et al. 2014).

c) key indicators to describe potential impacts,

Key indicators for describing potential impacts to Boreal Caribou and Eastern Migratory Caribou include both population indicators and habitat indicators.

Population Indicators

Boreal Caribou
Past surveys of Boreal Caribou in Ontario's Far North by the province of Ontario (~2009-2013) have provided estimates of population metrics for caribou across all continuous provincial Boreal Caribou ranges. Ontario has on-going caribou monitoring and research that may provide new information on caribou in this region. Indicators and metrics that align with those collected by Ontario can facilitate comparison through time to describe potential impacts to populations. Metrics measured by Ontario that may serve as useful indicators include:

- Minimum animal count;
- Population demographic parameters;
    - Sex ratio;
    - Pregnancy rate;
    - Recruitment rate; and
    - Adult survival and population growth rate.

Eastern Migratory Caribou
Many of the demographic population indicators suggested above for Boreal Caribou may also be appropriate for Eastern Migratory Caribou. However, data on many of these demographic parameters are not available for Eastern Migratory Caribou, except for minimum animal count, which was last estimated in 2011 (COSEWIC 2017).

Habitat and Other Indicators

Boreal Caribou

The federal amended recovery strategy for the Woodland Caribou (boreal population) (ECCC 2020) identifies critical habitat for all Boreal Caribou ranges in the assessment area as:

- The area within the boundary of each Boreal Caribou range that provides an overall ecological condition that will allow for an ongoing recruitment and retirement cycle of habitat; and
- Biophysical attributes required by Boreal Caribou to carry out life processes.

Further, the federal amended recovery strategy identifies 65% undisturbed habitat in a range as the disturbance management threshold, which provides a measurable probability (60%) for a local population to be self-sustaining (ECCC 2020).

Other potential indicators that may be important for Boreal Caribou include:

- Habitat and population connectivity; and
- Predator/prey dynamics such as the abundance of predator species in caribou habitat or frequency of predation events.

Eastern Migratory Caribou

No critical habitat has been defined for Eastern Migratory Caribou. Eastern Migratory Caribou rely on different habitat types throughout the year, mainly using tundra during calving and summer periods, and boreal forest during winter (COSEWIC 2017).

Recommended indicators for Eastern Migratory Caribou differ from Boreal Caribou and depend on the potential impacts that are being assessed. Useful indicators may include measures of:

- Habitat connectivity and population connectivity throughout the Southern Hudson Bay subpopulation range;
- Occupancy and habitat associations;
- Changes to calving grounds locations as a result of human disturbance;
- Changes to short- and long-term habitat availability; and
- Changes to mortality risk.

In addition, ECCC has developed a number of tools that may be helpful in describing potential impacts, such as:

- tools and methods for integrating national demographic-disturbance relationships and local demographic data that can be used to project cumulative effects of development on Boreal Caribou demography and viability, and can also be used to assess data needs and monitoring options (Publication: https://www.sciencedirect.com/science/article/pii/S1574954125001049);
- the Boreal Caribou Demographic Projection Explorer - an R Shiny App that allows users to explore projections of Boreal Caribou population dynamics. Projections include uncertainty about the current state of Boreal Caribou populations, and how those populations will change in the future (https://github.com/LandSciTech/CaribouDemographyBasicApp); and
- a Boreal Caribou population modeling approach that considers disturbance conditions, potential recovery actions, and population conditions, allowing population estimates to determine the likelihood of population recovery. This model was developed for caribou but could be adopted for other species at risk. Additional information can be shared upon request.

The following are still under development:

- climate change vulnerability assessments for species of concern, including species at risk that may be present within the project's area of influence. This work applies decision-support tools to support science-based assessments and climate adaptation strategies. This will include both migratory species and terrestrial species; and
- a new indicator to assess landscape connectivity that can be used to assess the potential effect of a development on ecological connectivity (and therefore animal movement). This is expected to be ready by spring 2026. Updates can be shared upon request.

d) <u>known data gaps or uncertainties,</u>

In addition to regional biodiversity data gaps mentioned above, there are data gaps related to:

- the ability to distinguish between Boreal Caribou and Eastern Migratory Caribou at the genetic level (which show no morphological differences) and ecotype-specific delineation of spatial distribution, population parameter estimates and habitat suitability;
- climate change and cumulative effects impacts on caribou in northern Ontario; and
- current relationships between wildlife and landscapes in the region, including the role of peatland type in Woodland Caribou habitat suitability in different seasons and different regions. For further details please see Attachment I (Project 2c) and Attachment V.

Further data gaps are organized by ecotype.

Boreal Caribou

Population Size Estimates

Population size estimates are not currently available for provincial or federal Boreal Caribou ranges in the assessment area. The best available data are minimum animal counts, which are difficult to compare between ranges or through time (MNRF 2014b; c; d; e; Szor et al. 2023; MECP 2024). Population size estimates could inform understanding of current caribou status in the region. Population size estimates for Boreal Caribou are typically based on winter surveys. For northern ranges where Boreal Caribou and Eastern Migratory Caribou overlap in winter, survey results include both ecotypes of caribou (as the two ecotypes cannot be visually distinguished). This increases uncertainty of population estimates from northern ranges.

Predation Risk

A knowledge gap exists around predation risk to Boreal Caribou by Grey Wolves (*Canis lupus*) or Black Bears (*Ursus americanus*) in northern Ontario, with little information available about current predator distribution or abundance. Wolves may reduce or even eliminate Boreal Caribou populations in areas where habitat has been significantly altered (COSEWIC 2002), and caribou declines have been associated with increased predation rates in areas with increases in anthropogenic disturbance (COSEWIC 2014). Black bears are also an important predator, with black bear predation accounting for more than 50% of caribou calf deaths in some regions of the Boreal Caribou range (COSEWIC 2014; Leclerc et al. 2014).

Location of Calving and Nursery Areas

A knowledge gap exists around locations of Boreal Caribou calving and nursery areas in the assessment area. Calving and nursery areas have specific habitat features required for this period of the life cycle, and female Boreal Caribou often exhibit a degree of fidelity to calving areas (Brown et al. 1986; Schaefer et al. 2000; Berglund et al. 2014). Female Boreal Caribou move away from other caribou during the calving and nursery period as a predator avoidance strategy, dispersing into areas where wolves and alternate prey are scarce (Bergerud and Page 1987; Berglund et al. 2014). It is not known how limiting these nursery and calving locations are in the assessment area, as there is limited information available (Berglund et al. 2014).

Eastern Migratory Caribou

Population Size Estimates

There is a lack of strong historical population size estimates for the Southern Hudson Bay subpopulation (COSEWIC 2017). Past surveys of the Southern Hudson Bay subpopulation have not been used to assess changes in population size as the location and timing of surveys was not ideal (COSEWIC 2017), as survey times and locations did not correspond with the timing of greatest aggregation, and an unknown proportion of the population was not surveyed (Berglund et al. 2014; COSEWIC 2017).

Population Trend

There is insufficient information to determine if there is a decline in the total number of mature individuals in the Southern Hudson Bay subpopulation (COSSARO 2017). The entire Eastern Migratory Caribou population as a whole has been documented declining substantially, with declines of 99% and 68% for the George River and Leaf River subpopulations in Quebec, respectively (COSEWIC 2017); however, indications of decline specific to Ontario are unclear because of a lack of trend data (COSSARO 2017). Monitoring of this population began in 1979 (Newton et al. 2015), and the most recent survey took place in 2011 (COSEWIC 2017; COSSARO 2017), but changing methods over time mean that these data cannot be used to estimate population trends.

Predation Risk

A high priority knowledge gap that has been identified is a lack of knowledge about baseline predation risk to Eastern Migratory Caribou by Grey Wolves (*Canis lupus*) in northern Ontario, with little information available about current predator distribution or abundance. Migratory behaviour to the Hudson Bay coast during calving and post-calving is assumed to take Southern Hudson Bay caribou outside the range of most predators, but some wolves follow migratory caribou over several hundred kilometres (Musiani et al. 2007; COSEWIC 2017). It remains unclear if wolves pose a large predation risk to Southern Hudson Bay caribou.

Wintering Ground Locations

Eastern Migratory Caribou of the Southern Hudson Bay subpopulation migrate inland into the boreal forest during the fall and winter. Radio collaring data suggest Eastern Migratory Caribou in this region may winter in different parts of their range in different years. Understanding the variation in movement patterns of Eastern Migratory Caribou in relation to the assessment area and development area is important for understanding the overall habitat use and potential impacts of future development to Eastern Migratory Caribou during winter.

e) <u>suggestions for studies or other ways to fill those gaps.</u>

The province of Ontario has been undertaking monitoring of Boreal Caribou across its range in Ontario, as well as undertaking research to fill knowledge gaps. As this information becomes available, it may help address some of the knowledge gaps identified in 2d. Potential studies that would be possible to undertake to fill identified knowledge gaps are outlined below. These studies would require extensive partnerships and resources.

Boreal Caribou

- Surveys aimed at updated population size and demographic estimates in provincial ranges overlapping the assessment area; and
- Continued monitoring of caribou predators (wolves and bears) through trail cameras and acoustics over a larger portion of the assessment area, to provide information on year-round caribou distribution and predation risk.

Eastern Migratory Caribou

- Surveys to estimate population size and provide baseline data to allow for population trends to be estimated over time for the Southern Hudson Bay subpopulation; and
- Continued monitoring of caribou predators (wolves and bears) through trail cameras and acoustics over a larger portion of the assessment area, to provide information on year-round caribou distribution and predation risk.

Other suggestions include:

- The development of a long-term monitoring framework for Boreal Caribou and Eastern Migratory Caribou based on ECCC's baseline genetic dataset (Project #2, Attachment I) to assess caribou population status over time.
- Provincially-owned caribou data for the RoF region has recently been made available to ECCC (via SARA s.11 agreement). As a result, it is now possible to pursue the development of models that better reflect current habitat use of caribou in Ontario's Far North and more accurately integrate information about the effects of anthropogenic disturbance. Such a model would allow interrogation of how proposed development in the Far North may affect caribou habitat use and movement.

Ongoing projects include:

- ECCC is currently refining a suite of genetic markers to be able to distinguish the two caribou ecotypes at the genetic level to enable the above analyses in the future (Project #2, Attachment I);
- ECCC and collaborators are currently exploring how the cumulative effects of climate change and resource extraction influence forest dynamics and the forest's ability to support Boreal Caribou and Indigenous communities inhabiting ecosystems in Northern Canada (including Ontario). This project could help to better understand caribou in Indigenous traditional territories in the RoF region, including the relationship with habitat disturbance (Project #9, Attachment I); and
- Work to collect better data, build better bird models, and develop better methods for assessing and communicating bird model reliability (Northern Ontario Bird Modelling Working Group, led by ECCC, Project #3, Attachment I)

Polar Bear:

a) <u>the best sources of existing data, including means to access it,</u>

There are considerable data on Polar Bears in the Southern Hudson Bay (SH) subpopulation, including tracking data on movements and distribution. The specific data on Polar Bears that would be useful in this assessment area are held by the province of Ontario (e.g., aerial surveys, previous inventory and capture work). The Nunavik Marine Regional Wildlife Board, Eeyou Marine Region Wildlife Board and Nunavut Wildlife Management Board conduct collaborative work in other areas of the SH subpopulation. Further data may be held by individual coastal Cree First Nation communities in Northern Ontario alongside their academic partners. The ECCC Polar Bear research group carries out collaborative research with both

Ontario and Quebec respective local communities in a large biopsy mark-recapture project. This involves using genetic techniques to identify individual bears throughout the SH and Western Hudson Bay (WH) subpopulations.

b) adequate spatial and temporal boundaries to assess impacts,

Polar Bear forage and move very broadly across the sea ice of Hudson Bay, therefore the spatial boundaries for the area of project assessment will need to be large. In addition, ECCC has documented high levels of movement of bears between the SH and WH subpopulations in some years. This is particularly true along the Manitoba/Ontario coast, suggesting that the risks to bears need to be assessed at several scales: at the level of the Hudson Bay complex (SH, WH, Foxe Basin), the subpopulation level (particularly SH, as this is the subpopulation that overlaps the assessment area), and at a local scale (community impacts). For published materials, see those listed under #8 (Attachment III).
Shapefiles of the spatial boundaries for all 20 subpopulations around the circumpolar Arctic can be accessed here: https://www.iucn-pbsg.org/population-status/
Adequate temporal boundaries to assess impacts will vary depending on the development activities being scoped into the assessment.

c) key indicators to describe potential impacts,

Polar Bears use marine and terrestrial habitats throughout the annual cycle. If assessing impacts from land developments, the impacts on bears would generally be for all bears when they are on land in summer and fall seasons, with additional measures being needed to protect den sites year-round. The timing and duration of time on land depends on the timing of sea ice formation and break up, and impacts all sex and age classes of bears. In addition, pregnant females spend 8 months in dens on land where they give birth to cubs, before emerging in February and returning to the sea ice with their cubs. Consequently, any development proposals need to consider the movement and habitat use of Polar Bears throughout the year, as well as incorporate interannual variation in the timing of environmental conditions.

The broader assessment area includes marine regions where other development could occur, e.g., shipping traffic, which may lead to impacts to Polar Bears if it impacts sea ice dynamics (i.e., ice breaking or changes during ice break up or ice formation). These types of impacts could be assessed by such measures as detailed sea ice metrics, or changes to Polar Bear movement patterns. Subpopulation specific assessments of impacts could include indices collected as part of long term subpopulation monitoring (e.g., bear number, cub number) as well as indices of Polar Bear health (e.g., body condition, cub recruitment) but note that surveys for subpopulation monitoring typically occur on a five year cycle. Due to the considerable movement between the SH and WH subpopulations, any changes would have to be assessed in relation to environmental factors and the changes in the neighbouring WH subpopulation. ECCC also has an extensive research expertise on contaminants in SH Polar Bears and can provide additional information if contaminants from development in Polar Bears are of interest to the RAWG.

In summary, the indicators used to assess potential impacts on Polar Bears will be highly project specific, and discussion with ECCC Polar Bear experts is strongly advised.

See also the proposed management plan, Part 1, Section 7 for information on performance indicators used within the management plan: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/management-plans/polar-bear-proposed-2025.html

d) known data gaps or uncertainties,

ECCC conducts long-term research on Polar Bear ecology and movements in WH. A key gap in understanding is the resiliency of Polar Bears to climate change, specifically with respect to sea ice dynamics. ECCC is seeing an increased ice-free period in Hudson Bay and increased variability in the patterns of formation and break up of sea ice due to climate change. Modeling suggests that there is an ice-free threshold beyond which these southerly Polar Bear populations will collapse. ECCC's ongoing work continues to document how environmental changes impact these Polar Bear subpopulations.
Part 1, Section 4 of the proposed management plan provides a list of threats and an assessment of data gaps to Polar Bears in the SH subpopulation: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/management-plans/polar-bear-proposed-2025.html
Table 1 from the Ontario Recovery Strategy, a component of the Federal Management Plan, also lists data gaps for the SH Polar Bear subpopulation: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery-strategies/polar-bear-ontario-2011.html

e) suggestions for studies or other ways to fill those gaps.

To identify areas of high bear densities and distributions at different times of the year, as well as denning records and distributions, existing data (i.e., genetic data, aerial survey data, tracking data, previous inventory and capture data) could be used to generate "heat maps". This would allow the "risk" of activities in areas to be better characterized for Polar Bears (without identifying precise bear locations, information that is highly sensitive). If the RAWG is interested in developing such a product, ECCC would be happy to discuss it further.
See the proposed Management Plan, Part 1, Section 6. Broad strategies and conservation measures, Table 5 for an outline of ECCC's research priorities for Polar Bear which are currently underway: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/management-plans/polar-bear-proposed-2025.html

Contamination:
ECCC's Wildlife and Ecosystem Health and Contaminants (WEHC) monitoring program under the Oil Sands Monitoring Program follows One Health and Environmental Effects Monitoring frameworks and has been co-developed and is being co-delivered through multiple partnerships with Indigenous-led Community Based Monitoring Programs. The WEHC program has been conducted since 2011 in a boreal region which contains similar ecosystems and wildlife species to the Ring of Fire area and thus is considered relevant. The monitoring program provides information to communities, to industry, and to regulatory agencies in response to the large-scale industrial development in the region which includes numerous bitumen surface mines.

a) the best sources of existing data, including means to access it,

While ECCC has very few datasets (Lukina et al., 2016) on environmental contaminants in the Ring of Fire region, ECCC has numerous datasets that contain information on wildlife health and contaminant burdens in both abiotic and biotic matrices from over a decade of integrated contaminants monitoring in Northern Alberta. In other words, there are many datasets that contain information on exposure and effects of Oil Sands-related contaminants (including mercury and other metals – which will be relevant to the development of the Ring of Fire area) on the indicator species and valued ecosystem components that are being monitored in the WEHC program. ECCC staff would be happy to provide more details in this data collection if there is interest.

b) adequate spatial and temporal boundaries to assess impacts,

ECCC could draw on the existing WEHC monitoring program in Northern Alberta to help identify spatial and temporal boundaries in the RoF area. From a spatial perspective, contaminant tissue residue data has been collected from various wildlife species from across Northern Alberta. A large spatial scale of coverage was needed to counteract the lack of temporal and baseline data available prior to oil sands development in Northern Alberta. For the Ring of Fire, setting spatial boundaries will require the consideration of numerous factors, including but not limited to the selected indicator species (e.g., the size of their range is important), prevailing winds (e.g., aerial deposition zone for dust and metals), and knowledge of hydrological connections. Contaminants can travel long-distances through various atmospheric processes (e.g., 'grasshopper effect' in which contaminants evaporate in warmer regions, travel through the atmosphere, and return to earth with rain and snow in colder areas, like the poles) and hydrological connections, including river transport. With respect to Oil Sands Monitoring (OSM), ECCC scientists have demonstrated that the Athabasca River is a conduit for contaminant transport downstream to the Peace-Athabasca Delta (Hebert 2019), a large inland delta located approximately 200 km north of the oil sands surface mineable region. As such, rivers in the Ring of Fire region (e.g., Albany, Attawapiskat, Ekwan Rivers) could potentially transport contaminants released from mining activities to other sensitive downstream ecosystems. From a temporal perspective, it is crucial to gather baseline contaminants data in *advance* of mining activities, to allow for a greater degree of confidence when interpretating the source (anthropogenic *vs.* natural) of contaminants data in abiotic and biotic samples; a current challenge of the OSM program given a lack of baseline data collected before development.

c) key indicators to describe potential impacts,

WEHC monitoring utilizes a variety of abiotic (e.g., sediment, surface water, passive sampling devices to measure contaminants in air and water) and biotic indicators to evaluate impacts of contaminants on the health of ecosystems. With respect to biotic indicator species, selected indicators represent different positions within aquatic and terrestrial food webs to evaluate contaminant fate and movement (e.g., bioaccumulation and biomagnification potential). Indicator species also represent different sized ranges to monitor environmental conditions at both local and regional scales. Selected indicator species are also of cultural importance to Indigenous land users (e.g., One Health approach that involves collaboration and co-development with local community-based monitoring programs). At present, WEHC monitoring includes amphibian species (e.g., wood frog), avian species (e.g., colonial waterbirds, including various gull and tern species), and mammals (e.g., muskrats and river otters). Tree swallows have also been utilized as an avian indicator species to assess potential impacts to avian health at a local scale. Plants (e.g., Labrador tea) and berries are also important indicators that are collected in partnership with local Indigenous communities (i.e., that could be used to inform future monitoring in the Ring of Fire).

d) known data gaps or uncertainties,

Lack of baseline data is a gap. As mentioned previously, the lack of true baseline data available in the oil sands region of Northern Alberta has presented challenges with respect to attributing present day changes measured in the environment because of mining activities, relative to natural sources and processes.

e) suggestions for studies or other ways to fill those gaps.

Field studies that target environmental sample collection *prior* to development of the Ring of Fire are suggested. Sampling site selection would also need to include a dose-response element, which would target sites located in close proximity to planned development, and sites located further afield (e.g., future reference sites). This refers to a Before-After Dose Response (BADR) sampling design, and is currently being employed in Northern Alberta, as part of the OSM program. Currently, WEHC monitoring in Northern Alberta partners with local communities to set priorities and co-develop wildlife monitoring projects. Similar designs, with an emphasis of engaging with local communities and land-users, is an efficient way to potentially complete baseline monitoring in the Ring of Fire region of Northern Ontario.

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Attachment III: #8 Species at Risk

a) Provide summaries of knowledge on species at risk and their habitat in the assessment area, including but not limited to threats, mitigation options, and knowledge gaps.
b) Comment on how Indigenous knowledge is braided in this knowledge.
c) Identify any plans for conservation and protection measures focused on the species at risk in the assessment area.

NOTE: Responsibility for wildlife conservation in Canada is shared between the federal, provincial, and territorial governments. The Species at Risk Act (SARA) was designed to work collaboratively with provincial and territorial legislation to protect species at risk. Under SARA, the federal government is responsible for migratory birds and aquatic species at risk wherever they occur, as well as terrestrial species at risk found on federal lands. For the purposes of this response, ECCC defines species at risk as species that are listed under Schedule 1 of the federal SARA as endangered, threatened, or special concern or species that have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered, threatened, or special concern.

Information provided below is based on all species at risk that have been recorded thus far within the boundary of the Ring of Fire Regional Assessment Area based on data from ECCC studies (as outlined in the March 2025 ECCC FAAR Response) and publicly available databases up to Fall 2024. In total, records are available of at least 39 species at risk, including 9 mammals, 25 birds, 1 reptile, 2 arthropods, 1 lichen and 1 vascular plant that have been recorded in the assessment area to-date (species lists are included in taxa subsections below). Some of these species are widespread in the assessment area and use the region for lifecycle functions including breeding, migratory stopover, or wintering, while other species may only be transient in the assessment area. For many species, information is available from only a limited number of observations, and further information including whether they use the assessment area for life-cycle functions remains limited. Throughout this response, ECCC provides an overview of what is known about each taxon and highlight where information may be limited.

Data availability for wildlife in northern Ontario is generally sparse, and this problem is exacerbated for species that are rare or sparsely distributed, as is common for species at risk (SAR). It is important to note that survey coverage remains sparse relative to the vast area under consideration and both survey effort and survey methodologies applied to date do not address all taxa equally. As such, the lists of species presented here are **preliminary** and records of additional species at risk may become available resulting from future surveys conducted in the assessment area.

ECCC also provides below some detailed responses to questions a)-c) on species where ECCC has conducted or been involved in more detailed study. Species-specific summaries are provided under their own subheading.

Upon request, ECCC may be able to provide additional expertise on specific migratory bird or SAR species.

All Species at Risk

This section provides an overview of knowledge of species at risk in the assessment area by species groups. For part a), for each species group, ECCC provides resources including provincial and federal recovery documents, threats summaries, and available guidance documents that assist in understanding the current state of knowledge, habitat, and potential mitigation options for these species. Note, more information on knowledge gaps for species at risk can be found in the response provided to #2d (Attachment II) for priority topic: “Wildlife and wildlife habitat including species at risk, migratory birds, and fish and fish habitat”.

For part b) ECCC provides a general overview of how Indigenous knowledge is braided into the recovery process under the *Species at Risk Act* (SARA). For part c), ECCC provides reference to relevant sections of the March 2025 ECCC FAAR Response. More information on protected areas as it relates to species at risk can be found in ECCC's response to #9.

a) <u>Provide summaries of knowledge on species at risk and their habitat in the assessment area, including but not limited to threats, mitigation options, and knowledge gaps.</u>

Mammals

General

Nine mammal species at risk are known from the assessment area (Table 1) based on observations from Natural Heritage Information Centre (NHIC), public databases, ECCC surveys, and published scientific papers. Information on mammal species at risk, while still sparse given the size of the assessment area, is more readily available than for many other taxa.

Two ecotypes of Woodland Caribou, Eastern Migratory Caribou and Boreal Caribou, are known to occur across the assessment area (see Figure 2 in the caribou section). Both ecotypes are present in the assessment area year-round, using different habitat types at different times of year, and both are known to breed within the assessment area. ECCC has undertaken and collaborated on surveys providing information on caribou in the assessment area between 2021 and 2025. More information can be found in the dedicated caribou subsection below.

Wolverine are also a year-round resident of the assessment area and rely on different habitat types for food and denning. Observations of wolverine have been captured during recent ECCC wildlife surveys.

Polar Bear primarily occur along the Hudson Bay/James Bay coast but may travel further inland in the summer months. More detailed information on Polar Bear is provided below in dedicated subsection below.

Four species at risk bats have also been observed in the assessment area, with observations primarily coming from studies by ECCC in 2021 and 2022, and a study by Layng et al. in 2019. Further information on bats is included in a separate subsubsection.

For all mammal species at risk, recovery documents and status assessments linked in Table 1 provide an overview of the species' habitat, as well as potential threats, mitigation options, and knowledge gaps.

Table 1. Available recovery documents for mammal species at risk (based on SARA listing or COSEWIC assessment) recorded within the Ring of Fire Assessment area. Species that were also observed within the smaller development area are indicated with a "Y".

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Links to available Recovery Documents
Caribou boreal population	Threatened	Threatened	Y	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr_Caribou_NF_Boreal_Atlantic_2014_e.pdf **Recovery Strategy (Canada):** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/plans/Rs-CaribouBorealeAmdMod-v01-2020Dec-Eng.pdf **Recovery Strategy (Ontario):** https://www.ontario.ca/page/woodland-caribou-recovery-strategy **Action Plan (Canada):** https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/Ap-WoodlandCaribouBorealPopulationFederalActions-v00-2018Feb-Eng.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2017/06/Accessible_COSSARO-evaluation-Caribou-Boreal.pdf
Caribou (eastern migratory population)	No Status	Endangered	Y	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr_Caribou%20Eastern%20Migratory%20Torngat%20Mountains%20populations_2017_e.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2018/06/Accessible_COSSARO_Evaluation_Migratory_Caribou_FINAL_31JAN2018.pdf
Eastern Red Bat	No Status	Endangered	Y	**COSEWIC Assessment and Status Report:** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/hoary-bat-eastern-red-bat-silver-haired-bat-2023.html **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2024/04/Eastern-Red-Bat_COSSARO-Assessment-Report_Final.pdf

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Links to available Recovery Documents
Hoary Bat	No Status	Endangered	Y	**COSEWIC Assessment and Status Report:** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/hoary-bat-eastern-red-bat-silver-haired-bat-2023.html **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2024/04/Hoary-Bat_COSSARO-Assessment-Report_Final.pdf
Little Brown Myotis	Endangered	Endangered	Y	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr_Little%20Brown%20Myotis&Northern%20Myotis&Tri-colored%20Bat_2013_e.pdf **Recovery Strategy (Canada):** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/plans/Rs-TroisChauveSourisThreeBats-v01-2019Nov-Eng.pdf **Recovery Strategy (Ontario):** https://files.ontario.ca/mecp-rs-bats-2019-12-05.pdf **COSSARO Candidate Species at Risk Evaluation:** https://www.ontario.ca/page/little-brown-myotis-evaluation
Northern Myotis	Endangered	Endangered		**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr_Little%20Brown%20Myotis&Northern%20Myotis&Tri-colored%20Bat_2013_e.pdf **Recovery Strategy (Canada):** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/plans/Rs-TroisChauveSourisThreeBats-v01-2019Nov-Eng.pdf **Recovery Strategy (Ontario):** https://files.ontario.ca/mecp-rs-bats-2019-12-05.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://files.ontario.ca/environment-and-energy/species-at-risk/stdprod_101777.pdf

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Links to available Recovery Documents
Polar Bear	Special Concern	Special Concern		**COSEWIC Assessment and Status Report:** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/polar-bear-2018.html **Management Plan (Proposed):** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/00020681-RECPRO_DT0088-en-mp_polar_bear_e_proposed.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2022/04/COSSARO_Polar-Bear_Final.pdf
Silver-haired Bat	No Status	Endangered	Y	**COSEWIC Assessment and Status Report:** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/hoary-bat-eastern-red-bat-silver-haired-bat-2023.html **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2024/05/Silver-haired-Bat_COSSARO-Assessment-Report_Final.pdf
Wolverine	Special Concern	Special Concern	Y	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr_Wolverine_2014_e.pdf **Recovery Strategy (Canada):** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/plans/rs_wolverine_eastern_population_e_final.pdf **Recovery Strategy (Ontario):** https://www.ontario.ca/page/wolverine-recovery-strategy **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2017/12/AccessibleCOSSAROevalWolverine.pdf

Threats

For the mammal species listed in Table 1, some COSEWIC assessments and recovery documents include an IUCN (International Union for Conservation of Nature) threat assessment, which outline the expected severity, scope, and timing of standard categories of threats (https://www.iucnredlist.org/resources/threat-classification-scheme; COSEWIC 2022). It is important to note that IUCN threat assessments are typically applied across the range of the population or designatable unit, and thus caution must be used when applying these threat assessments to specific regions. Threat assessments specific to the Ring of Fire assessment area may yield different results than what is presented in species recovery strategies. Nevertheless, the available IUCN threat assessments give an indication of which threats should be considered for each species.

IUCN threat assessments include consideration of scope (i.e. the proportion of the total population affected), severity (i.e. the overall declines caused by the threat) and timing (i.e. past, ongoing, or future). As scope is typically estimated for the population or designatable unit (DU) as a whole, and the assessment area may only contain a proportion of the population or DU, ECCC does not summarize results for scope here. Similarly, timing is assessed based on timing of specific potential impacts at the time of the threat assessment, and likely did not consider potential impacts that could occur sometime in the future in the assessment area. For these reasons, ECCC has only summarized information from recovery documents on severity (i.e. the overall declines caused by the threat), which may be more applicable at different scales.

For the mammal species at risk with available IUCN Threat Assessments, ECCC has compiled below the severity rankings of threats under category 3 – Energy production & mining and 4 – Transportation & service corridors. Table 2 provides an overview for these categories. Estimates of severity may not be specific to northern Ontario portions of the species' range and the information compiled below may change for threat assessments specific to the Ring of Fire, but the information is included here to provide some indication of whether the listed threats are likely to be important for each species. Information for other threat categories are available in the recovery documents for each species.

Table 2. Threat severity based on available IUCN threat assessments in species at risk recovery documents for mammal species observed in the Ring of Fire Assessment Area. Note that the columns 3. and 4. indicated in grey are a cumulative ranking based on the associated subcategories.

Common Name	3. Energy production and mining	3.1 Oil and gas drilling	3.2 mining and quarrying	3.3 Renewable Energy	4. Transportation and service corridors	4.1 road and railroads	4.2 utility and service lines	4.3 shipping lanes	4.4 flight paths
MAMMALS									
Caribou boreal population	Moderate-Slight	Moderate-Slight	Extreme		Moderate	Moderate	Moderate-Slight		
Caribou eastern migratory population	Serious-Moderate	Moderate-Slight	Serious-Moderate	Moderate-Slight	Slight	Slight	Negligible		Negligible
Eastern Red Bat	Serious			Serious	Slight	Slight			
Hoary Bat	Extreme-Serious			Extreme-Serious	Slight	Slight			
Little Brown Myotis	Serious-Moderate	Slight-Negligible	Moderate	Serious-Moderate	Slight	Slight	Slight-Negligible		
Northern Myotis	Moderate-Slight	Slight-Negligible	Moderate	Moderate-Slight	Slight	Slight	Slight-Negligible		
Polar Bear	Extreme	Extreme	Extreme		Negligible	Negligible	Negligible	Negligible	Neutral or Potential Benefit
Silver-haired Bat	Serious		Extreme	Serious	Slight	Slight			
Wolverine	Slight	Slight	Slight	Negligible	Slight	Slight	Slight		

Birds

General

Prior to 2021, when ECCC surveys were initiated, most data for breeding birds in Ontario's remote North were about 20 years old, with most of the samples located in the habitat types adjacent to and near the major navigable rivers at locations accessible by canoe and collected using a single-visit point count. Data from the Ontario Breeding Bird Atlas 2 (Atlas 2; https://www.birdsontario.org/atlas-2/) collected in 2001-2005 was limited to habitat types adjacent to and near major navigable rivers, and collected using a single visit point count. After 2021, ECCC conducted bird surveys in portions of the assessment area and in adjacent areas and watersheds. Recent ECCC surveys are contributing to the current Ontario Breeding Bird Atlas (Atlas-3; survey phase of 2021-2025). The Ontario Breeding Bird Atlas contributes to breeding range assessments and provides information on range changes, population distributions, and habitat associations. Analysis of Atlas-3 data in the coming years will greatly advance knowledge on birds in Ontario, including in the Ring of Fire assessment area.

Twenty-five bird species at risk have been recorded in the Ring of Fire assessment area, based on information from ECCC acoustic surveys, the Ontario Breeding Bird Atlas, and other publicly available datasets and observations (Table 3). For migratory waterfowl and shorebirds, the coasts of James and Hudson bays provide the only tidal saltwater habitats between the maritime arctic and the Gulf of St. Lawrence and the Atlantic and Gulf of Mexico (Riley 2011).

The assessment area covers a large area and not all SAR birds listed below are present throughout the entire assessment area. Further, some species may be transient in parts of the assessment area, while others rely on habitat within the assessment area for important functions such as breeding or migratory stopover sites. For species listed below, information from databases such as Naturecounts (https://naturecounts.ca/nc/default/explore.jsp) and NatureServe (https://explorer.natureserve.org/) can aid in understanding the distribution of these species both within and outside the Ring of Fire Assessment Area.

In Table 3 ECCC lists SAR birds that best available information suggests have been observed in the Ring of Fire assessment area, and the relevant recovery documents for each. For each, ECCC also notes whether observations occur in the development area, and known uses of the assessment area by that species such as breeding, migration, or year-round residence.

In addition to the species listed in Table 3, two bird species, Connecticut Warbler and Marbled Godwit, have been recorded in the assessment area and currently have COSEWIC assessments in progress.

Table 3. Available recovery documents for bird species at risk (based on SARA listing or COSEWIC assessment) recorded within the Ring of Fire Assessment area. Species that were also observed within the smaller development area are indicated with a "Y". Assessment Area Likely Use(s) describes best available information on the life stages that each species is likely to be carrying out in the Assessment Area, based on available species range maps, recovery documents and expert knowledge.

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Assessment Area Likely Use(s)	Links to available Recovery Documents
Bank Swallow	Threatened	Threatened	Y	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://publications.gc.ca/collections/collection_2013/ec/CW69-14-669-2013-eng.pdf **Recovery Strategy (Canada):** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/plans/rs-HirondelleRivageBankSwallow-v00-2022Apr-eng.pdf **Recovery Strategy (Ontario):** https://www.ontario.ca/page/recovery-strategy-bank-swallow **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2017/06/Final-COSSARO-Evaluation-Bank-Swallow-Sep-19-2013-FINAL-s.pdf
Barn Swallow	Threatened	Special Concern	Y	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr%20Barn%20Swallow%202021_e.pdf **Recovery Strategy (Ontario):** https://www.ontario.ca/page/barn-swallow-recovery-strategy **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2022/04/COSSARO-Barn-Swallow-Dec-20-2021.pdf

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Assessment Area Likely Use(s)	Links to available Recovery Documents
Bobolink	Threatened	Special Concern	N	Migration	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr%20Bobolink%202022_e.pdf **Recovery Strategy (Canada) (Proposed):** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/plans/rs_bobolink_e_proposed.pdf **Recovery Strategy (Ontario):** https://files.ontario.ca/environment-and-energy/species-at-risk/mnr_sar_rs_est_mdwlrk_en.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2023/04/COSSARO-Bobolink-November-2022_final.pdf
Buff-breasted Sandpiper	Special Concern	Special Concern	N	Migration	**COSEWIC Assessment and Status Report:** https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_becasseau_roussatre_buffbreasted_sandpiper_1012_e.pdf **Management Plan (Proposed):** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/management-plans/buff-breasted-sandpiper-proposed-2021.html
Canada Warbler	Threatened	Special Concern	Y	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr_Canada_Warbler_2020_e.pdf **Recovery Strategy (Canada):** https://www.sararegistry.gc.ca/virtual_sara/files/plans/rs_canada%20warbler_e_final.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2022/04/COSSARO_report-for-Canada-Warbler-Final.pdf

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Assessment Area Likely Use(s)	Links to available Recovery Documents
Chimney Swift	Threatened	Threatened	N	Breeding Possible but Not Confirmed	**COSEWIC Assessment and Status Report:** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/chimney-swift-2018.html **Recovery Strategy (Canada):** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery-strategies/chimney-swift-2023.html **Recovery Strategy (Ontario):** https://www.ontario.ca/page/chimney-swift-recovery-strategy **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2021/04/ChimneySwift_August2020_Final.pdf
Common Nighthawk	Special Concern	Special Concern	Y	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/common-nighthawk-2018.html **Recovery Strategy (Canada):** https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/rs_common%20nighthawk_e_final.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2021/04/COSSARO_Common-Nighthawk_2020_Final-Jan-2021.pdf

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Assessment Area Likely Use(s)	Links to available Recovery Documents
Eastern Meadowlark	Threatened	Threatened	N	Migration	**COSEWIC Assessment and Status Report:** https://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_eastern_meadowlark_0911_eng.pdf **Recovery Strategy (Canada) (Proposed):** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery-strategies/eastern-meadowlark-proposed-2022.html **COSSARO Candidate Species at Risk Evaluation:** https://files.ontario.ca/environment-and-energy/species-at-risk/stdprod_091154.pdf
Eastern Whip-poor-will	Threatened	Special Concern	N	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr-EasternWhip-poor-will-v00-2022-eng.pdf **Recovery Strategy (Ontario):** https://files.ontario.ca/mecp-rs-easternwhip-poor-will-2019-12-05.pdf **Recovery Strategy (Canada):** https://publications.gc.ca/collections/collection_2018/eccc/En3-4-300-2018-eng.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2024/04/Eastern-Whip-poor-will_COSSARO-Assessment-Report_Final.pdf
Eastern Wood-pewee	Special Concern	Special Concern	N	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_Eastern%20Wood-pewee_2013_e.pdf **Management Plan (Proposed):** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/management-plans/eastern-wood-pewee-proposed-2023.html **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Assessment Area Likely Use(s)	Links to available Recovery Documents
					content/uploads/2017/06/Final-COSSARO-Evaluation-Eastern-Wood-Pewee-_23-Sep-2013_GFM-FINAL-s.pdf
Evening Grosbeak	Special Concern	Special Concern	Y	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr_Evening%20Grosbeak_2016_e.pdf **Management Plan:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/plans/mp_evening_grosbeak_e_final.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2018/06/AccessibleCOSSAROEvaluation_EveningGrosbeak_FINAL_30JAN2018.pdf
Harris's Sparrow	Special Concern	Special Concern	N	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/cosewic/sr_Harris%27s%20Sparrow_2017_e.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2018/06/Accessible_COSSARO_Evaluation_Harriss_Sparrow-COSSARO_FINAL_14FEB2018.pdf
Horned Grebe	No Status	Special Concern	N	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr-HornedGrebeEsclavon-v00-2023-eng.pdf **Management Plan:** https://www.ontario.ca/page/horned-grebe-management-plan

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Assessment Area Likely Use(s)	Links to available Recovery Documents
Hudsonian Godwit	No Status	Threatened	N	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/Sr-BargeHudsonianGodwit-v00-2019-Eng.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2021/04/Hudsonian-Gotwit_final.pdf **Recovery Strategy (Ontario):** https://www.ontario.ca/page/hudsonian-godwit-recovery-strategy
Lesser Yellowlegs	No Status	Threatened	Y	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr_Lesser_Yellowlegs_2020_e.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2022/04/COSSARO_LesserYellowlegs_Dec2021.pdf **Recovery Strategy (Ontario):** https://www.ontario.ca/files/2024-06/mecp-lesser-yellowlegs-recovery-strategy-en-2024-06-25.pdf
Olive-sided Flycatcher	Special Concern	Special Concern	Y	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/olive-sided-flycatcher-2018.html **Recovery Strategy (Canada):** https://www.sararegistry.gc.ca/virtual_sara/files/plans/rs_olive-sided%20flycatcher_e_final.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2021/04/COSSARO_Olive-Sided-Flycatcher_Final.pdf

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Assessment Area Likely Use(s)	Links to available Recovery Documents
Prothonotary Warbler	Endangered	Endangered	N	Migration	**COSEWIC Assessment and Status Report:** https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_protonotaria_citrea_e.pdf **Recovery Strategy (Canada):** https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/rs_prothonotary_warbler_0311_e.pdf **Recovery Strategy (Ontario):** https://www.ontario.ca/page/prothonotary-warbler-recovery-strategy **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2018/06/AccessibleCOSSAROEvaluation_ProthonotaryWarbler_FINAL_30JAN2018.pdf
Red Knot *rufa* subspecies	Endangered	Endangered	N	Migration	**COSEWIC Assessment and Status Report::** https://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_calidris_canutus_e.pdf **Recovery Strategy (Ontario):** https://files.ontario.ca/red-knot-rufa-subspecies-recovery-strategy-en.pdf **Recovery Strategy and Management Plan (Canada):** https://publications.gc.ca/collections/collection_2018/eccc/En3-4-260-2017-eng.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2022/04/COSSARO_RedKnot_NE-SouthAmerica_Final.pdf

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Assessment Area Likely Use(s)	Links to available Recovery Documents
Red-necked Phalarope	Special Concern	Special Concern	N	Breeding, Migration	**COSEWIC Assessment and Status Report::** https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_Red-necked%20Phalarope_2014_e.pdf **Management Plan (Proposed):** https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/management-plans/red-necked-phalarope-proposed-2022.html **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2017/06/Accessible_COSSARO-evaluation-Red-necked-Phalarope.pdf
Rusty Blackbird	Special Concern	Special Concern	Y	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_rusty_blackbird_0806_e.pdf **Management Plan:** https://www.sararegistry.gc.ca/virtual_sara/files/plans/mp_rusty_blackbird_e_final.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2018/06/Accessible_COSSARO_Evaluation_Rusty-Blackbird_FINAL_06FEB2018.pdf
Short-billed Dowitcher *hendersoni/ griseus*	No Status	Threatened	Y	Breeding, Migration	Registry page: https://species-registry.canada.ca/index-en.html#/species/3035-2536

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Assessment Area Likely Use(s)	Links to available Recovery Documents
Short-eared Owl	Special Concern	Threatened	N	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/cosewic/sr%20Short-eared%20Owl%202021_e.pdf **Management Plan:** https://publications.gc.ca/collections/collection_2019/eccc/En3-5-94-2018-eng.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2022/04/COSSARO_Short-eared-Owl-September-2021-final.pdf
Snowy Owl	NA	Threatened	N	Over-wintering, Migration	The snowy owl was assessed by COSEWIC as threatened in May 2025 but the report is not yet available. The press release is available here: https://cosewic.ca/index.php/en/assessment-process/detailed-version-may-2025.html Registry Page: https://species-registry.canada.ca/index-en.html#/species/380-2543
Wood Thrush	Threatened	Threatened	N	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://publications.gc.ca/collections/collection_2013/ec/CW69-14-664-2013-eng.pdf **COSSARO Candidate Species at Risk Evaluation:** https://cossaroagency.ca/wp-content/uploads/2017/06/Final-COSSARO-Evaluation-Wood-Thrush-Feb-2013-final_GFM-FINAL-s.pdf
Yellow Rail	Special Concern	Special Concern	N	Breeding, Migration	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr-RaleJauneYellow%20Rail-v00-2023-eng.pdf **Management Plan:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/plans/mp_yellow_rail_e_final.pdf

Mitigation Options:

For birds listed in Table 3, ECCC has also compiled some useful links to publicly available Best Management Practices, Factsheets, and other Guidance Documents produced by a variety of agencies and organizations that may be relevant to each of the species and provide information on options for mitigation.

This is not an exhaustive list but may serve as a useful starting point. Additional guidance documents may be available from other organizations or agencies.

General documents:

Birds and Bird Habitats: Guidelines for Wind Power Projects

Species-specific documents:

Bank Swallow, Barn Swallow, and Chimney Swift:

Best management Practices for the Protection, Creation and Maintenance of Bank Swallow Habitat in Ontario (PDF)

Birds Canada - AIstewardshipBrochure - Page 1

Best Practices Technical Note: Creating Nesting Habitat for Barn Swallows (PDF)
Birds Canada - Barn Swallow Host_2022_English - Page 1

Birds Canada - Chimney Swift Host_national_2023 - Page 1

Common Nighthawk:

National-Nightjar-Survey-Protocol-WildResearch-2019.pdf

Eastern Whip-poor-will:

National-Nightjar-Survey-Protocol-WildResearch-2019.pdf

Birds Canada - EWPW_Brochure_FINAL_Nov2022 - Page 1

Knowledge Gaps:

More information on knowledge gaps for birds in the assessment area can be found in the ECCC response to 2d in Attachment II.

Reptiles

General

Information on species at risk reptiles in the assessment area comes primarily from a single observation far south of the development area. Without further surveys, it is unknown how widespread reptiles may be across the assessment area, whether they may be present in the development area, or if other SAR reptiles may be in the assessment area. It is important to note that for Snapping Turtle (Table 4), distribution maps in recovery documents suggest that the assessment area is north of the expected range for this species, and so it is possible that this species only occurs in the southern-most portions of the assessment area.

Table 4. Available recovery documents for reptile species at risk (based on SARA listing or COSEWIC assessment) recorded within the Ring of Fire Assessment area. Note that no species were observed in the development area and observations are drawn from a limited number of observations in a small portion of the assessment area.

Common Name	Current SARA Status	COSEWIC Assessment Status	Links to available Recovery Documents
Snapping Turtle	Special Concern	Special Concern	**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr_snapping_turtle_0809_e.pdf **Management Plan:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/plans/mp_snapping_turtle_e_final.pdf

Mitigation Options

Some general guidance documents such as Best Management Practices are publicly available for reptiles and snakes as produced by other agencies and organizations including the Province of Ontario. This is not an exhaustive list but may serve as a useful starting point. Additional guidance documents may be available from other organizations or agencies.

Amphibians and Reptiles:

Best Management Practices for Mitigating the Effects of Roads on Amphibian and Reptile Species at Risk in Ontario (PDF)

Reptile and Amphibian Exclusion Fencing: Best Practices

Managing and Enhancing Terrestrial Road Ecology (2021) | Transportation Association of Canada (TAC)

Arthropods

There have been very few surveys for arthropods in Ontario's Far North, and as such information on arthropod species at risk is limited. While Yellow-banded bumble bee and monarch are the only SAR arthropods observed in the assessment area to-date, more survey effort throughout the assessment area may lead to the detection of other SAR.

Bees:

Bumble bees are known to occur at high latitudes throughout Canada. Occurrence and distribution of bees and other pollinators in Ontario's Far North are not well understood, due to lack of survey effort. Two recent published studies, both part of the province of Ontario's Far North Biodiversity Project (FNBP), provide the only large-scale survey information available on bees in Ontario's Far North. Both include new regional records and range extensions, showing that the region is highly under-sampled (Gibson et al. 2018; Vizza et al. 2021).

One SARA listed bumble bee, the Yellow-banded Bumble Bee (Special Concern) is known to occur in Ontario's Far North, with recent records in the assessment area (Gibson et al. 2018). One other SARA listed species, the Gypsy Cuckoo Bumble Bee (Endangered) and one COSEWIC assessed species Suckley's Cuckoo Bumble Bee (assessed Threatened), have the potential to occur in the assessment area due to historic records in the Moosonee area, and the presence of a potential host species, the Yellow Banded Bumble Bee.

Recovery documents for Yellow-banded bumble bee note that Mining and Quarrying (3.2), may be a threat with extreme-serious severity for the population.

Monarch:

The inclusion of Monarch in Table 5 below is based on very limited publicly available observations in the very southern portion of the assessment area. Monarch's breed exclusively on milkweed plants (*Asclepias* spp.), therefore breeding habitat is confined to the range of milkweed plants. Milkweed may occur in the southern portions of the Ring of Fire assessment area, including in gardens beyond the expected northern range limit for these plant species.

Other:

While there are observations of Transverse Lady Beetle in the assessment area based on data from NHIC and Global Biodiversity Information Facility (GBIF; Figure 1), these observations come from preserved specimens prior to 1980 and it is therefore uncertain whether the species is currently in the assessment area. As such, the Transverse Lady Beetle is not included in the table below but may be observed in the assessment area with further targeted arthropod surveys.

Table 5. Available recovery documents for arthropod species at risk (based on SARA listing or COSEWIC assessment) recorded within the Ring of Fire Assessment area. Species that were also observed within the smaller development area are indicated with a "Y".

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Links to available Recovery Documents
Monarch	Endangered	Endangered		**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/sr_Monarch_2016_e.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2021/04/Final-COSSARO_Monarch-2020.pdf
Yellow-banded Bumble Bee	Special Concern	Special Concern	Y	**COSEWIC Assessment and Status Report:** https://publications.gc.ca/collections/collection_2016/eccc/CW69-14-715-2015-eng.pdf **Management Plan:** https://publications.gc.ca/collections/collection_2023/eccc/En3-5-140-2023-eng.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2017/06/Accessible_COSSARO-evaluation-Yellow-banded-Bumble-Bee.pdf

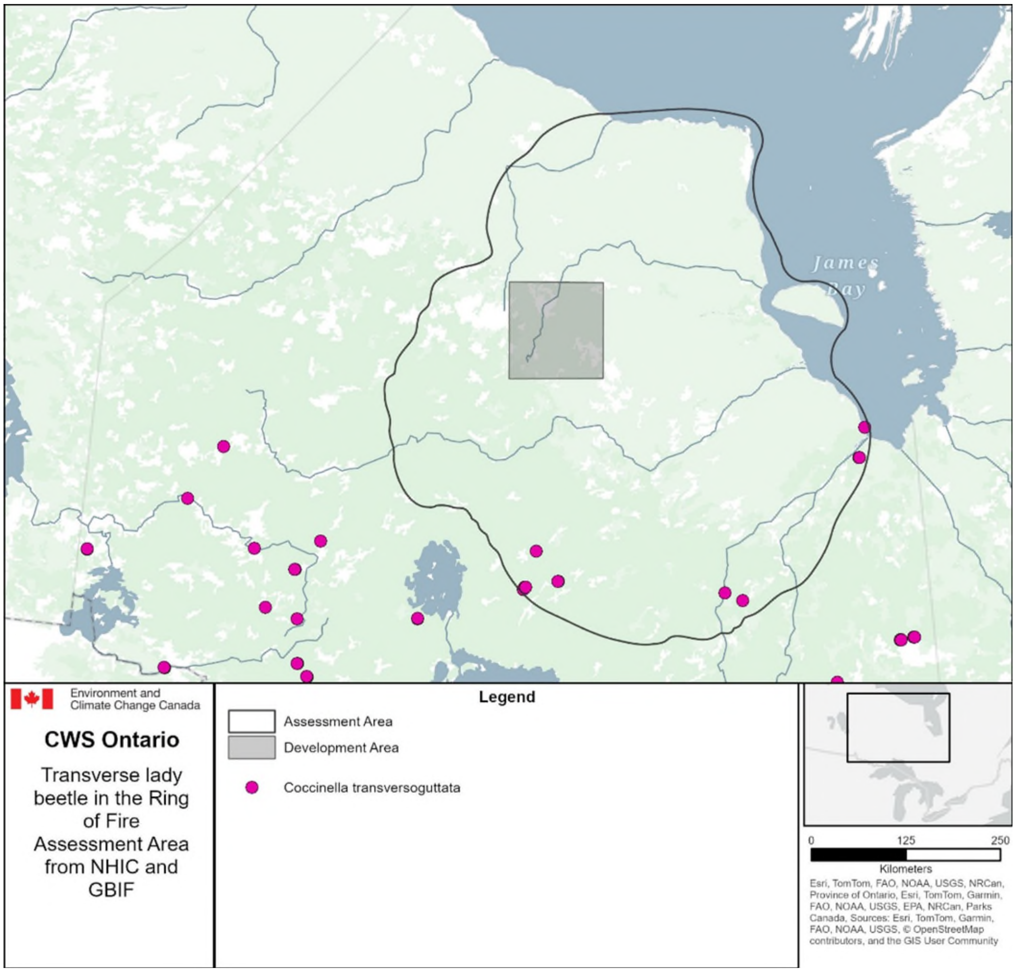

Figure 1. Observations of transverse lady beetle in the Ring of Fire Assessment Area from NHIC and GBIF. All observations in the assessment area occurred prior to 1980.

Lichen and Vascular Plants

One at risk lichen species and one at risk vascular plant species have been recorded in the assessment area (Table 6) based on available observations drawn from public databases and the Natural Heritage Information Centre (NHIC).

The Province of Ontario hosts a resource outlining assessment guidelines for black ash: Black Ash assessment guidelines.

Table 6. 6 Available recovery documents for lichen and vascular plant species at risk (based on SARA listing or COSEWIC assessment) recorded within the Ring of Fire Assessment area. Species that were also observed within the smaller development area are indicated with a "Y".

Common Name	Current SARA Status	COSEWIC Assessment Status	Recorded in Development Area	Links to available Recovery Documents
LICHEN				
Flooded Jellyskin	Special Concern	Special Concern	Y	**COSEWIC Assessment and Status Report:** https://publications.gc.ca/collections/collection_2016/eccc/CW69-14-391-2016-eng.pdf **Recovery Strategy (Canada):** https://www.sararegistry.gc.ca/virtual_sara/files/plans/rs_flooded_jellyskin_e.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2017/06/COSSARO-Flooded-Jellyskin-Evaluation-Draft-with-FR-FINAL-s.pdf
VASCULAR PLANTS				
Black Ash	No Status	Threatened		**COSEWIC Assessment and Status Report:** https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/cosewic/FreneNoirBlackAsh-2019-Eng.pdf **Recovery Strategy (Ontario):** https://files.ontario.ca/pdf-3_0/mecp-black-ash-recovery-strategy-en-2022-08-10.pdf **Ontario Species at Risk Evaluation Report (COSSARO):** https://cossaroagency.ca/wp-content/uploads/2021/04/COSSARO_Evaluation_blackash_FINAL.pdf

b) Comment on how Indigenous knowledge is braided in this knowledge

ECCC's usual process for consultations includes engagement with Indigenous communities/stakeholders within the species range, at the stage of listing on to Schedule 1 of SARA which includes:

- Notification of all Nations of the respective species through email and mail (including information on Listing process, species ecology, and questionnaires to assist correspondence and information sharing)
- A workshop to engage with and discuss the species in question, their possible reason for listing and inquire about Indigenous concerns and knowledge of the species (starting point for additional workshops, one on one meetings, training, etc.)

A similar process occurs following the formulation of a draft recovery document, on a more granular scale for Indigenous communities, whose reserves overlap critical habitat units of SAR species, and any Indigenous communities/stakeholders, who've requested further engagement for the respective species. Indigenous stakeholders are given 60 days to request follow-up meetings, provide input or comments, and raise concerns. Following this period, reviews are conducted, meetings are had, and subsequent changes are made to the document based on acquired Indigenous knowledge.

Extending beyond ECCC's regulatory consultations related to listing and recovery planning, additional activities have been undertaken with First Nations and Indigenous organizations that have facilitated the incorporation of Indigenous knowledge in conservation initiatives including sharing of survey protocols and translation of relevant text.

Some of these activities for SAR that occur near the assessment area are listed below.

- Workshops (often multi-community workshops unless specified), such as:
  - Monarch Open Standards;
  - SARA 101 Overview;
  - Monarch Butterfly Early Engagement;
  - Shorebirds of Ontario;
  - Two-eyed Seeing Breeding Bird Atlas;
  - Early Planning Workshops (Boreal Caribou, Eastern Migratory Caribou, Wolverine, Monarch, Migratory Bats);
  - Requesting Input on Draft Conservation Action Plan for Shorebirds;
  - SARA Consultation, Cooperation, and Accommodation Barn Swallow Project;
  - Mission Monarch Expert Training Program & Butterfly and Habitat Survey Overview;
  - Mission Monarch Expert Survey Pilot;
  - Priority Place Initiative for Species at Risk: Conservation Implementation Plan;
  - Caribou Surveys in the Far North;
  - Foxsnake, Turtles & Bats Indigenous Communities' Presentation; and
  - Eastern Migratory Caribou Pre-listing.
- Permit Applications, including with Michipicoten First Nation
- One-on-One Meetings, such as:
  - Polar Bear Management Plan Discussion with Weenusk First Nation;
  - Pre-consultation calls for Red-necked Phalarope;
  - SAR Enquiry on Bats w/ Missanabie Cree First Nation; and
  - Caribou Survey Presentation to Mushkegowuk Council.

c) Identify any plans for conservation and protection measures focused on the species at risk in the assessment area

Information on general protection measures relevant to species at risk in the assessment area are outlined in the March 2025 ECCC FAAR Response under the following sections:

2. Regulatory authority - Subsections on *Species at Risk Act* and *Migratory Bird Convention Act* which include an explanation of critical habitat protections.

4. Policy, Programs or Initiatives - Subsections on "Habitat Conservation and Protection Programs, Policies and Initiatives" which include information on protected areas.

Caribou

Note: From a regulatory perspective, caribou management and protection within the assessment area is primarily the responsibility of Ontario. ECCC is committed to working collaboratively with the provinces and territories on the recovery and conservation of Boreal Caribou. ECCC regularly meets with Ontario's Ministry of the Environment, Conservation, and Parks to discuss and collaborate on shared interests including the protection and recovery of species at risk and their habitat in Ontario as it relates to federally listed terrestrial species at risk.

a) Provide summaries of knowledge on species at risk and their habitat in the assessment area, including but not limited to threats, mitigation options, and knowledge gaps.

ECCC has drafted a report (CWS-ON Interim report on biodiversity in the Ring of Fire region – Caribou) which summarizes more detailed information on knowledge of caribou and its habitat in the assessment area. The report is under review to take into account recently shared provincial data on caribou and will be made available at a later date. The following information is provided in the meantime.

Background

Two ecotypes of Woodland Caribou (*Rangifer tarandus caribou*) occur in Ontario, including in the assessment area: Boreal Caribou and Eastern Migratory Caribou. Boreal Caribou are listed as Threatened under the federal *Species at Risk Act* (SARA) and are a priority species under the pan-Canadian approach to transforming species at risk conservation in Canada. Eastern Migratory Caribou are under consideration for addition to SARA as Endangered based on an assessment and status report by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) released in 2017.

The ecotypes are not visually distinguishable and are instead primarily distinguished based on female anti-predator strategies during the calving season, such that Eastern Migratory Caribou migrate to specific areas to calve, overwhelming predators with high densities of prey, while Boreal Caribou are widely dispersed during calving to reduce the frequency of encounters with predators. Both boreal and Eastern Migratory Caribou are present in the assessment area year-round; however, Eastern Migratory Caribou demonstrate large and extensive movement patterns (Berglund et al. 2014; Pond et al. 2016), while Boreal Caribou make small and more concentrated annual movements (Berglund et al. 2014; Pond et al. 2016). The inability to distinguish these ecotypes visually creates difficulty in determining population size estimates for each ecotype.

The development area is within the federal Boreal Caribou Far North range and overlaps three provincial Boreal Caribou ranges: Missisa, Ozhiski, and James Bay (Figure 2). The assessment area also overlaps portions of the Nipigon, Pagwachuan, Brightsand, Kinloch, and Kesagami ranges. Boreal Caribou are broadly present across the assessment area year-round and use the assessment area and the development area for all life stages.

The development area also overlaps with the southern boundary of the federal Eastern Migratory Caribou range (Figure 2). Eastern Migratory Caribou are present in the development area primarily in the winter but are found in other parts of the assessment area year-round. Eastern Migratory Caribou calve along the Hudson Bay coast in the northern portion of the assessment area.

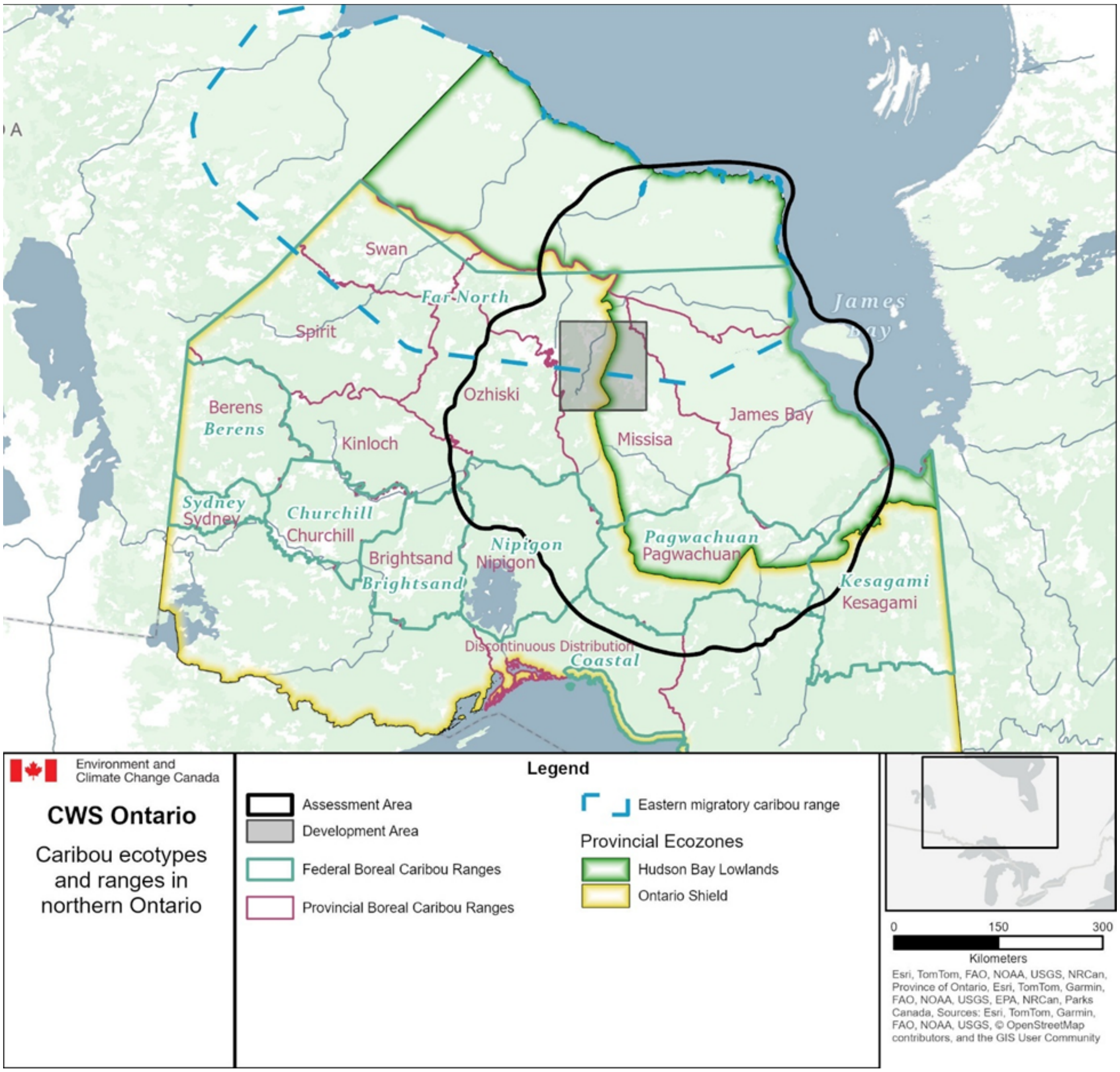

Figure 2. Caribou ranges in Ontario showing federal and provincial ranges for Boreal Caribou and subpopulation range for the Southern Hudson Bay Eastern Migratory Caribou subpopulation, overlaid with the Ring of Fire assessment and development areas as outlined in the Terms of Reference for the RA.

Population sizes/trends

Boreal Caribou

Caribou ranges in Ontario's Far North contain relatively low percentages of anthropogenic and natural disturbance and large continuous undisturbed tracts of habitat (ECCC 2024). This facilitates genetic exchange between populations and has led to high rates of genetic diversity amongst individuals compared to more fragmented populations further south. There is currently no Boreal Caribou range-wide population size estimate for the federal Far North Boreal Caribou range that overlaps the assessment area, due to insufficient data. Published provincial Boreal Caribou range-wide estimates in this region are based on data collected prior to 2013 (MNRF 2014a; c; d;e; MECP 2024; and Szor et al. 2023). Ontario has on-going caribou monitoring and research that may provide new information.

Predation is a major contributing factor to population declines of Boreal Caribou, and human development in previously undeveloped areas can potentially increase predation risk to caribou by wolves (*Canis lupus*) and other predators (Environment Canada 2012). Predation risk to caribou populations in Ontario's Far North remains poorly understood, and little information is available about current predator distribution or abundance.

Eastern Migratory Caribou

The most recent minimum animal count for Eastern Migratory Caribou in the Southern Hudson Bay subpopulation occurred in 2011, with an estimate of 16,638 derived from minimum count surveys and photographic aerial surveys (COSEWIC 2017). However, this is not a total population size estimate, as published surveys are not available for parts of the range (COSEWIC 2017).

Habitat

Boreal Caribou

Boreal Caribou in Ontario are broadly distributed across the boreal forest, which, in the absence of anthropogenic disturbances, is characterized by large, natural disturbance events (predominantly forest fires and blowdown). Over time, this creates a shifting pattern of young forests generally not used by Boreal Caribou, interspersed with large (>100 km^2) tracts of older conifer forest (>40-60 years) that are used by caribou year-round (MNRF 2014c).

The Ontario Shield ecozone covers the Swan, Spirit, Kinlock, Ozhiski, and the western portion of the Missisa Boreal Caribou ranges in Ontario's Far North, as well as the southern portion of the Pagwachuan boreal range (Figure 2). In the Ontario Shield, Boreal Caribou inhabit areas characterized by jack pine and black spruce dominated forests with a high density of lakes and lake complexes, commonly used for calving and nursery activities (MNRF 2014c).

In the Hudson Bay Lowlands ecozone, which covers the eastern portion of the Missisa range, the James Bay range, and portions of the Pagwachuan range (Figure 2), the landscape is relatively flat and dominated by black spruce lowlands with very poor drainage. There are large river systems and extensive wetlands throughout the area, and a much less aggressive forest fire regime than in the Ontario Shield (MNRF 2014c). Boreal Caribou calving and nursery activity areas in this ecozone appear to be mostly associated with poor conifer swamp complexes, swamp and fen complexes, parallel linear swamp features, or upland areas separated by bogs and fens, and sometimes small bog islands, or treed edges of large fen complexes (MNRF 2014c). During winter, Boreal Caribou largely avoid very large fens, but will use the perimeters of fens and bog islands within fens during the summer (MNRF 2014c). Due to differences in vegetation and climate in the Hudson Bay Lowlands ecozone, Boreal Caribou tend to have larger home ranges, aggregate in larger winter groups, and have different seasonal movement patterns than Boreal Caribou in other regions of the province (Hazell and Taylor 2011; Berglund et al. 2014). Boreal Caribou in the Hudson Bay Lowland ecozone therefore tend to require larger areas to carry out life processes than those in the Ontario Shield ecozone (MNRF 2014c).

Eastern Migratory Caribou

Eastern Migratory Caribou undertake long bi-annual migrations, calving on tundra areas with sparse vegetation, summering in tundra-like habitats, migrating south to taiga and boreal habitats in the fall, wintering in the taiga and boreal forest, and migrating back to calving grounds in the spring (COSEWIC 2017). In Ontario, Eastern Migratory Caribou move between Hudson Bay coastal areas and interior regions each year, with some segments of the subpopulation moving in large circles between the coast and interior over the year (Berglund et al. 2014; COSEWIC 2017).

Further details on habitat use of boreal and Eastern Migratory Caribou based on published information and ECCC-led surveys will be included in the CWS-ON Interim report on biodiversity in the Ring of Fire region – Caribou once shared.

Threats and Mitigation Options

The complete review of anticipated direct threats to Boreal Caribou and Eastern Migratory Caribou populations, based on a literature review compiled by ECCC, will be provided in Appendix D of the caribou report.

ECCC completed a review of anticipated direct threats to Boreal Caribou and Eastern Migratory Caribou populations and their habitat in the RoF region using the Threat Classification Scheme implemented by the International Union for Conservation of Nature and Conservations Measures Partnership (IUCN-CMP) (Salafsky et al. 2008; IUCN 2019). Threats were assessed based on a desktop review of the impacts of mining and industrial development within caribou ranges in Ontario. As the specific infrastructure designs of anticipated mining projects in the assessment area are not yet known, this review considers general impacts of mining and associated activities on the boreal and eastern migratory ecotypes of Woodland Caribou. Furthermore, this review considers threats to Boreal and Eastern Migratory Caribou throughout all anticipated future mining phases (i.e., exploration, mine development and operation, mine closure and site rehabilitation, and monitoring and maintenance) which are expected to continue over the next several decades.

Although found in the same region, differences between ecotypes are expected to cause certain threats to affect Eastern Migratory Caribou differently than they affect Boreal Caribou. Due to the large annual movements undertaken by Eastern Migratory Caribou, major threats to this ecotype include linear disturbance interruption/bisection of migration routes (IUCN 4), problematic species that are likely to affect Eastern Migratory Caribou calving grounds and/or transmit parasites that impede Eastern Migratory Caribou movement (IUCN 8), and climate change caused phenological mismatch between migration timing and environmental characteristics (IUCN 11). For Boreal Caribou major threats include habitat alteration and habitat loss from energy production and mining (IUCN 3) and transportation and service corridors (IUCN 4), increased risk of predation from linear disturbances creating travel corridors for predators (IUCN 4), and climate change resulting in more frequent extreme weather events degrading caribou health and habitat (IUCN 11).

In addition to mitigation options outlined in recovery documents, there are multiple guidance documents and best management practices that may assist in guiding conservation activities. Below are examples of some available documents. This is not an exhaustive list but may serve as a useful starting point. Additional guidance documents may be available from other organizations or agencies.

Best Management Practices for Tourism Activities and Woodland Caribou in Ontario

Best Management Practices for Mineral Exploration and Development Activities and Woodland Caribou in Ontario

Best Management Practices for Renewable Energy, Energy Infrastructure and Energy Transmission Activities and Woodland Caribou in Ontario

Further details on threats and mitigation measures will be found in the report excerpt on caribou in the Ring of Fire region once shared.

Knowledge Gaps

Information on knowledge gaps can be found in the response to question 2d (Attachment II) under Caribou.

b) Comment on how Indigenous knowledge is braided in this knowledge

Local Indigenous knowledge has been collected on caribou and wolves during both caribou and wolf projects. During caribou fecal DNA surveys in 2025, a community member contributed local knowledge regarding caribou distribution, changes in movement patterns, and increases in predation pressure by wolves.

In 2022, ECCC funded and provided advice to a local tribal council to deploy trail cameras and autonomous recording units (ARUs) around a community within the assessment area. Through this project, local knowledge was gathered and used to inform the best locations for the trail cameras and ARUs to be deployed to capture caribou and their predators in later work. Further local knowledge was gathered during this project on wolf packs in the area, which provided information to ECCC regarding potential predation pressure to caribou.

c) Identify any plans for conservation and protection measures focused on the species at risk in the assessment area

Information on the 'Agreement for the Conservation of Caribou, Boreal Population in Ontario', is provided in the March 2025 ECCC FAAR Response under section 3, subheading caribou.

Polar Bear

a) Provide summaries of knowledge on species at risk and their habitat in the assessment area, including but not limited to threats, mitigation options, and knowledge gaps.

In Canada, Polar Bears can be found in Manitoba, Newfoundland and Labrador, Northwest Territories, Nunavut, Ontario, Québec, and Yukon. The Ring of Fire development and assessment area in Ontario's Far North overlaps with the range for the Polar Bear Southern Hudson Bay (SH) subpopulation (Figure 3).

Polar Bear has been listed as a species of Special Concern in Canada under the federal *Species at Risk Act* (SARA) since 2011, following a reassessment by the Committee on the Status of Endangered Wildlife in

Canada (COSEWIC) in 2008. The committee reconfirmed the status of Special Concern when it reassessed the species in 2018.

The projected loss of sea ice is the primary threat to the species, reducing the availability of habitat and access to prey. Other threats identified in the proposed Management Plan (Environment and Climate Change Canada, 2025) include contaminants, tourism, mining and quarrying, marine shipping and biological resource use. Pathogen prevalence linked to climate change is an emerging threat.

The draft federal management plan for Polar Bear provides summaries of knowledge of Polar Bear in Canada, including habitat needs, threats, knowledge gaps, and recommended recovery actions (https://species-registry.canada.ca/index-en.html#/consultations/bsN7eI6eGulCP1Rv0cbno).

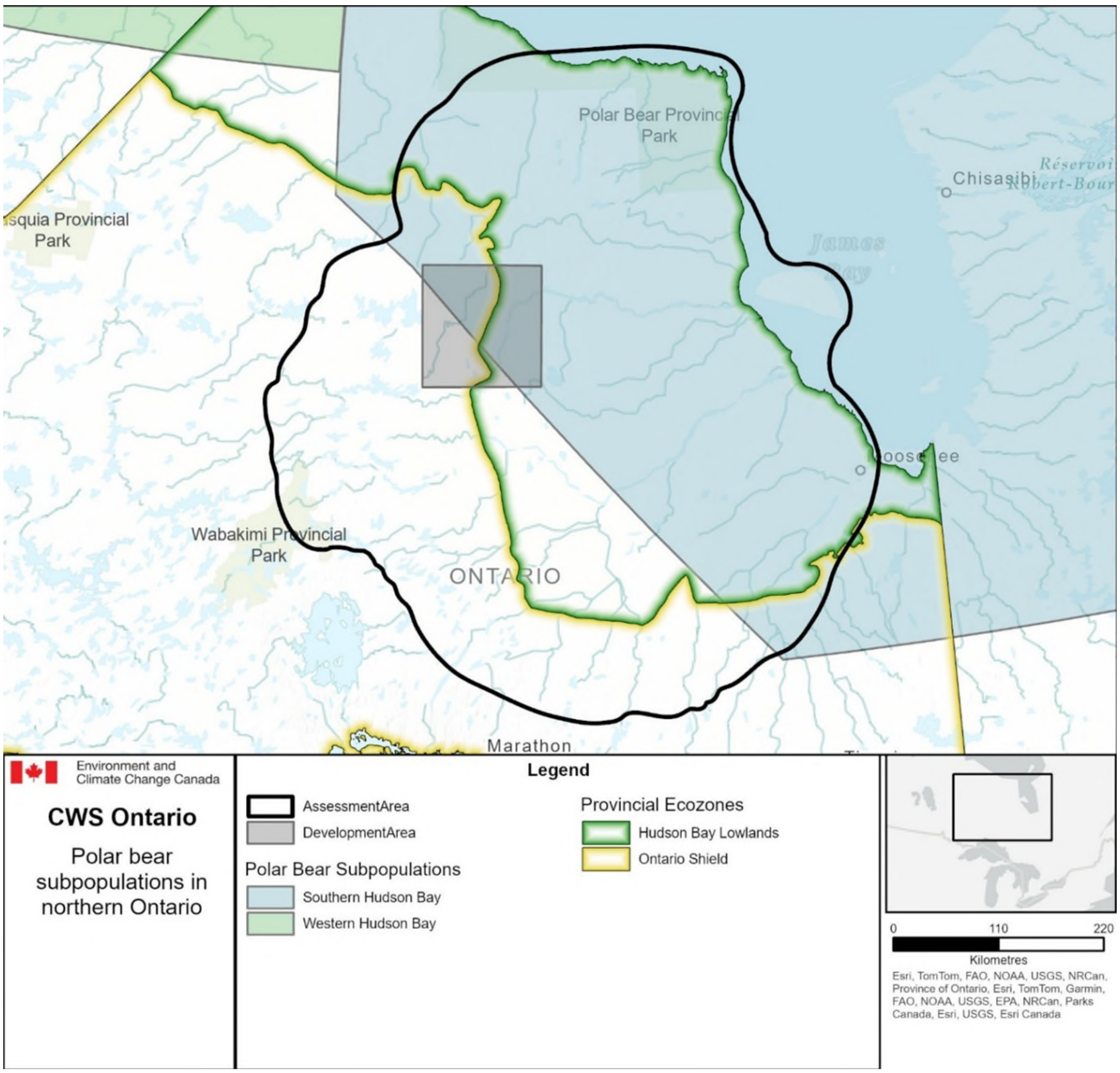

Figure 3. Polar Bear subpopulations in the assessment and development areas as outlined in the Terms of Reference for the Ring of Fire Regional Assessment.

Considerations for the SH subpopulation include (https://nmrwb.ca/wp-content/uploads/2025/02/Witness-JoeNorthrup-polar-bear-scientific-information.pdf):

1. It is at the southernmost extent of the species range and is experiencing changes in climate and sea-ice availability and timing. The result is a longer open water season in Hudson Bay, meaning bears are on land longer and unable to feed on their preferred high energy diet of seals. Communities are reporting more human-bear interactions, making mitigations important for settlements (e.g., garbage management). A decline in body condition has been documented in the population since the 1980s.
2. Most bears in the SH summer along the coast in Ontario (fewer in Quebec) and a large portion of that area is in the Ring of Fire Assessment Area.
3. Bears located in James Bay (including those on Akimiski Island) show a level of genetic distinctiveness not found elsewhere. Their movements seem more contracted than others in the SH subpopulation. This is an active area of research into the factors (e.g., behavioural, changes in sea-ice breakup timing and patterns) that may explain this finding. For example, see work by Alexandra Langwieder with the Eeyou Marine Region Wildlife Board (Polar Bear Ecology in the Eeyou Marine Region – Eeyou Marine Region Wildlife Board). ECCC has an ongoing collaborative genetics and genomics projects with the Government of Ontario as well.
4. There is a high degree of connectivity among bears in SH with those in Western Hudson Bay and also to the north in Foxe Basin. Therefore, harvest and other environmental impacts in these neighboring subpopulations and their population trajectories also influence those in SH.

Published literature that may be relevant as it relates to the Southern Hudson Bay Population of Polar Bear is listed below. Contact ECCC if there is trouble accessing any of the reports listed below:

1. Canada's 2024 CITES NDF for Polar Bear.
    - French https://www.canada.ca/fr/environnement-changement-climatique/services/convention-commerce-international-especes-menacees-extinction/avis-commerce-non-prejudiciable/ours-blanc.html
    - English https://www.canada.ca/en/environment-climate-change/services/convention-international-trade-endangered-species/non-detriment-findings/polar-bear.html
    - Inuktitut https://www.canada.ca/en/environment-climate-change/services/convention-international-trade-endangered-species/non-detriment-findings/polar-bear-iu.html

2. Cromption, A.L., Obbard, M.E., Petersen, S.D., and P.J. Wilson. 2008 Population genetic structure in Polar Bears (Ursus maritimus) from Hudson Bay, Canada: Implication of future climate change. Biological Conservation 141(10): 2528-2539 https://doi.org/10.1016/j.biocon.2008.07.018

3. Eeyou Marine Region Wildlife Board (EMRWB) 2020. Cree knowledge of Polar Bears in the Eeyou Marine Region: A report based on information shared by Cree knowledge holders from the coastal communities of: Whapmagoostui, Chisasibi, Wemingji, Eastmain, and Waskaganish. 54 pp.

4. Laforest, B. J., Hébert, J. S., Obbard, M. E., & Thiemann, G. W. (2018). Traditional ecological knowledge of Polar Bears in the Northern Eeyou Marine Region, Québec, Canada. *Arctic*, *71*(1), 40-58.

5. Langwieder, A., Coxon, A., Loutit, N., Varty, S., Boulanger, F., Diamond, S., Lameboy, J., Jolly, A., Natawapineskum, G., Okima, D., and M.M. Humphries. 2023. Community-led non-invasive Polar

Bear monitoring in the Eeyou Marine Region of James Bay, Canada: insights on distribution and body condition during the ice-free season. Facets https://doi.org/10.1139/facets-2022-0226

6. McGeachy, D., Lunn, N.J., Northrup, J.M., Trim, V., Davis, C., and Derocher, A.E. (2023). Distributional shifts of Polar Bears (*Ursus maritimus*) in Hudson Bay in relation to sea ice dynamics, 2017-2022 Final Report. Environment and Climate Change Canada, 32 pp.

7. Northrup, J.M., Howe, E., Lunn, N.J., Middel, K., Obbard, M.E., Ross, T.R., Szor, G., Walton, L., and Ware, J. 2022. 2021 Southern Hudson Bay Polar Bear subpopulation aerial survey. Ontario Ministry of Natural Resources and Forestry, Peterborough, 52 pp.

8. Nunavik Marine Regional Wildlife Board (NMRWB). 2018. Nunavik Inuit knowledge and observations of Polar Bears: Polar Bears of Southern Hudson Bay sub-population. Project conducted and report prepared by the NMRWB by Basterfield, M., Breton-Honeyman, K., Furgal, C., Rae, J. and M. O'Connor. Xiv + 73 pp.

9. Regehr, E., M. Dyck, G. Gilbert, S. Iverson, D. Lee, N. Lunn, J. Northrup, A. Penn, M.-C. Richer and G. Szor. 2019. Provisional Harvest Risk Assessment for the Southern Hudson Bay Polar Bear Subpopulation. Report to the Southern Hudson Bay Polar Bear Subpopulation Advisory Committee, 07 June 2019. Unpublished report. 75 pp.

10. Southern Hudson Bay Technical Working Group 2024. Southern Hudson Bay subpopulation status report. Prepared for the Southern Hudson Bay Advisory Committee, 44 pp.

11. Southern Hudson Bay Technical Working Group. 2023. Options document for recommending the overall harvest level of the Southern Hudson Bay Polar Bear subpopulation considering the updated abundance estimate from the 2021 aerial survey. Prepared for the Southern Hudson Bay Advisory Committee. Addendum to Regehr, E., M. Dyck, G. Gilbert, S. Iverson, D. Lee, N. Lunn, J. Northrup, A. Penn, M.-C. Richer and G. Szor. 2019. Provisional Harvest Risk Assessment for the Southern Hudson Bay Polar Bear Subpopulation. Report to the Southern Hudson Bay Polar Bear Subpopulation Advisory Committee, 07 June 2019. Unpublished report. 75 pp.

12. PBTC Status Table 2024 - Polar Bear Technical Committee (PBTC) | Polar Bears in Canada

13. Middel, K.R. and Obbard, M.E., 2024. Sea ice dynamics influence movement patterns of adult female Polar Bears in southern Hudson Bay. Ursus, 2024(35e17), pp.1-27.

14. Obbard, M.E. and Middel, K.R., 2012. Bounding the Southern Hudson Bay Polar Bear subpopulation. Ursus, 23(2), pp.134-144.

15. Obbard, M.E., McDonald, T.L., Howe, E.J., Regehr, E.V. and Richardson, E.S., 2007. Polar Bear population status in southern Hudson Bay, Canada. US Geological Survey Administrative Report. US Department of the Interior, Reston, VA.

16. Obbard, M.E., Stapleton, S., Middel, K.R., Thibault, I., Brodeur, V. and Jutras, C., 2015. Estimating the abundance of the Southern Hudson Bay Polar Bear subpopulation with aerial surveys. Polar Biology, 38, pp.1713-1725.

17. Obbard, M.E., Cattet, M.R., Howe, E.J., Middel, K.R., Newton, E.J., Kolenosky, G.B., Abraham, K.F. and Greenwood, C.J., 2016. Trends in body condition in Polar Bears (*Ursus maritimus)* from the Southern Hudson Bay subpopulation in relation to changes in sea ice. Arctic Science, 2(1), pp.15-32.

18. Obbard, M.E., Stapleton, S., Szor, G., Middel, K.R., Jutras, C. and Dyck, M., 2018. Re-assessing abundance of Southern Hudson Bay Polar Bears by aerial survey: effects of climate change at the southern edge of the range. Arctic Science, 4(4), pp.634-655.

19. Regehr, E.V., Dyck, M., Iverson, S., Lee, D.S., Lunn, N.J., Northrup, J.M., Richer, M.C., Szor, G. and Runge, M.C., 2021. Incorporating climate change in a harvest risk assessment for Polar Bears *Ursus maritimus* in Southern Hudson Bay. Biological Conservation, 258, p.109-128.

20. Stroeve, J., Crawford, A., Ferguson, S., Stirling, I., Archer, L., York, G., Babb, D. and Mallett, R., 2024. Ice-free period too long for Southern and Western Hudson Bay Polar Bear populations if global warming exceeds 1.6 to 2.6° C. Communications Earth & Environment, 5(1), p.296.

21. Viengkone, M., Derocher, A.E., Richardson, E.S., Obbard, M.E., Dyck, M.G., Lunn, N.J., Sahanatien, V., Robinson, B.G. and Davis, C.S., 2018. Assessing spatial discreteness of Hudson Bay Polar Bear populations using telemetry and genetics. Ecosphere, 9(7), p.e02364.

Knowledge Gaps:

More information on knowledge gaps for Polar Bear in the assessment area can be found in the ECCC response to 2.d) (Attachment II) and in the proposed management plan (Environment and Climate Change Canada, 2025).

b) Comment on how Indigenous knowledge is braided in this knowledge

Recently (November 2024 & February 2025) the Nunavik Marine Region (NMR) Wildlife Management Board and Eeyou Marine Region (EMR) Wildlife Management Board held public hearings regarding the "consideration for non-quota limitations for Polar Bears in the NMR and EMR." During this public hearing, a large amount of western science and Indigenous Knowledge was shared and publicly documented for the Southern Hudson Bay Polar Bear population. All hearing materials are available online: https://nmrwb.ca/polar-bear-nqls-public-hearing-2024/#142-142-wpfd-top-p2 and include reports on the Southern Hudson Bay Population such as:

- Nunavik Marine Regional Wildlife Board (NMRWB). 2018. Nunavik Inuit knowledge and observations of Polar Bears: Polar Bears of Southern Hudson Bay sub-population. Project conducted and report prepared by the NMRWB by Basterfield, M., Breton-Honeyman, K., Furgal, C., Rae, J. and M. O'Connor. Xiv + 73 pp.

as well as presentations from ECCC:

- Polar Bear Subpopulation Status in Southern Hudson Bay https://nmrwb.ca/wp-content/uploads/2025/02/ECCC-Science-Presentation-Phase-II-NQl-Hearings-February-2025.pdf
- ECCC Overview of Polar Bear Management Roles and Responsibilities https://nmrwb.ca/wp-content/uploads/2025/02/21.-ECCC-Management-Deck-Phase-2-NQL-Hearing.pdf

Further, the proposed "Management Plan for the Polar Bear (Ursus maritimus) in Canada" included members and leaders from three First Nations in the Ring of Fire region as advisors.

c) Identify any plans for conservation and protection measures focused on the species at risk in the assessment area

See information above on "Management Plan for the Polar Bear (Ursus maritimus) in Canada". ECCC may be able to provide expertise and recommendations on conservation and protection measures that may be effective for Polar Bear in the assessment area as more information on specific anticipated impacts or projects is provided, and as more data on Polar Bear in the region is collected.

Bat Species at Risk

a) Provide summaries of knowledge on species at risk and their habitat in the assessment area, including but not limited to threats, mitigation options, and knowledge gaps.

Background

Up to six bat species have been recorded in Far North Ontario, with five species at risk bat detected within the assessment area. Little Brown Myotis (*Myotis lucifugus*) and Northern Myotis (*Myotis septentrionalis*) are listed as endangered under SARA, while Eastern Red Bat (*Lasiurus borealis*), Silver-haired Bat (*Lasionycteris noctivagans*) and Hoary Bat (*Lasiurus cinereus*) have been assessed by COSEWIC as endangered. Little Brown Myotis and Northern Myotis are hibernating species while Eastern Red Bat, Silver-haired Bat, and Hoary Bat are considered migratory species.

Prior to ECCC surveys in the assessment area, the best available information on bat occurrence in Ontario's Far North comes from acoustic data collected across the region by Layng et al. (2019) between 2010 and 2014. Survey locations in Layng et al. (2019) were sparsely distributed across a vast area of Ontario's Far North and provide a preliminary overview of potential bat distribution.

ECCC surveys in the assessment area have not been systematic, but rather opportunistic alongside surveys for birds and mammals in the region in 2021 and 2022. Preliminary results detected 4 above-mentioned SAR bats in the assessment area. ECCC surveys to-date have only covered a small portion of the assessment area and do not reflect the full potential distribution of bat species or range of habitats within the assessment area.

In 2021-2022, ECCC contracted the Toronto Zoo to write a report on the status of knowledge of bats in Ontario's Far North, including identification and prioritization of knowledge gaps. The full Bats of the Far North report has been included with this response (Attachment VI). Note that at the time of this report, acoustic monitoring data collected by ECCC had not yet been analyzed and Eastern Red Bat, Hoary Bat, and Silver-haired Bat COSEWIC assessments had not yet been completed.

Habitat

Migratory bats

Very few data exist for migratory bats in boreal regions. No published studies describe the roosting and migratory behaviour of these species in the far north of their ranges, although these requirements are moderately understood for southern populations. Foraging Eastern Red Bats, Hoary Bats, and Silver-haired Bats were observed to associate with mixed forest stands in northern Alberta (Lausen, 2014). Open habitat and forest clear cuts were associated with Eastern Red Bat and Hoary Bats in central Ontario (Jung et al., 1999; Mills et al., 2013).

Hibernating bats

Little Brown Myotis and Northern Myotis spend their summers roosting in cavities such as hollow trees, buildings, or artificial roost boxes. These roosts are used by 'maternity colonies' that may include up to several hundred females that switch roosts as frequently as nightly. Little Brown Myotis typically forage around these maternity roosts over open water, wetlands, or riparian habitat, and show high fidelity to foraging and roosting areas through the summer months.

Little Brown Myotis and Northern Myotis overwinter in hibernacula, but very little is known about where hibernacula may occur in Far North Ontario. For example, there was no information available on hibernacula in northern Ontario to inform the federal Recovery Strategy (published in 2015) for Little Brown Myotis, Northern Myotis, and Tri-colored Bat in Canada. In 2023-2024, a contractor of ECCC conducted a preliminary desktop analysis of habitat variables that may predict hibernacula locations in northern Ontario, but further work is needed to refine this model.

Threats

<u>All species at risk bats</u>

Renewable energy (IUCN 3.3) is a potentially severe threat to all bat species, particularly as it relates to wind energy (Environment and Climate Change Canada 2018). However, very little data is available on the impact of wind power developments in the boreal forest, as most data to-date comes from information further south in the ranges of these bat species.

Mining and quarrying (IUCN 3.2) is noted as a potential threat to bats, particularly for hibernating bats like Little Brown Myotis and Northern Myotis (Environment and Climate Change Canada, 2018) but has not been investigated in the boreal portion of their ranges.

<u>Hibernating bats</u>

With the rapid spread of White-nose Syndrome (WNS) in populations of hibernating bats in Canada (first detected in Ontario as early as 2009, and on the north shore of Lake Huron as early as 2013), disease continues to be a major threat to hibernating bats (COSEWIC 2013). The most up-to-date detections for the spread of WNS can be found at https://www.whitenosesyndrome.org/where-is-white-nose-syndrome.

Mitigation Options

In addition to mitigation options outlined in bat recovery documents, there are multiple guidance documents and best management practices that may assist in guiding conservation activities. Below are examples of some available documents. This is not an exhaustive list but may serve as a useful starting point. Additional guidance documents may be available from other organizations or agencies.

A synthesis of operational mitigation studies to reduce bat fatalities at wind energy facilities in North America (PDF)

Canadian National White-nose Syndrome Decontamination Protocol for entering bat hibernacula (PDF)

Agency Guide to Cave and Mine Gates (PDF)

Bats and bat habitats: guidelines for wind power projects (PDF)

Bats: enjoy them from a distance (PDF)

Bats in buildings: a guide to safe and humane exclusions (PDF)

Things you can do to promote bat conservation (PDF)

Welfare and Handling Recommendations.2023-07_EN.pdf (PDF)

Best Practices for use of Bat Houses Link: 241311

Knowledge Gaps:

More information on knowledge gaps for bat species at risk in the assessment area can be found in the ECCC response to 2.d) (Attachment II).

b) Comment on how Indigenous knowledge is braided in this knowledge

Information from contractor reports has been shared with interested First Nations in the Ring of Fire region for information and input.

c) Identify any plans for conservation and protection measures focused on the species at risk in the assessment area

See the assessment reports and recovery strategies included in Table 1 for information on conservation and protection measures for bats generally.

Shorebirds (Hudsonian Godwit, Lesser Yellowlegs, Short-billed Dowitcher, and Red Knot)

a) Provide summaries of knowledge on species at risk and their habitat in the assessment area, including but not limited to threats, mitigation options, and knowledge gaps.

Detailed information on these species can be found in reports provided as part of the March 2025 ECCC FAAR Response. The assessment area provides key breeding habitat for this group of species, but little is known about the amount of available breeding habitat relative to species needs.

b) Comment on how Indigenous knowledge is braided in this knowledge

Indigenous knowledge is braided in this knowledge through collaboration on projects with Mushkegowuk Council and First Nations within the region. The development of these projects is ongoing.

c) Identify any plans for conservation and protection measures focused on the species at risk in the assessment area

A draft Conservation Action Plan was initiated in 2024 to guide conservation efforts for at-risk shorebirds in Ontario. This working document outlines initial priorities and strategies based on the Open Standards for the Practice of Conservation (Conservation Standards; https://www.conservationstandards.org/), which provide a structured framework for adaptive and results-based conservation planning. The plan is a living document and will continue to be refined through ongoing review, collaboration, and integration of new knowledge.

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Attachment IV: Included datasets may be entirely or partially contained within the boundary of the RoF assessment area. The blue column has been added to provided information on “means to access” data. Note that one dataset has been removed since the previous ECCC FAAR response in March 2025 as it relied on outdated landcover layers and therefore is no longer considered a reliable resource.

Category	Subcategory	Title	Description	Primary Contact Type (Dept, Branch, Ministry, FN, Other)	Ownership	Partners	Format	Parameters	Spatial Coverage	Time Period - Start	Time Period - End	Status	Study Objectives	Method	Means to access
Protected Areas	Planning	Canadian Protected and Conserved Areas Database	The Canadian Protected and Conserved Areas Database (CPCAD) contains the most up to date spatial and attribute data on marine and terrestrial protected areas (PA) and other effective area-based conservation measures (OECM) in Canada. CPCAD is compiled and managed by Environment and Climate Change Canada (ECCC), in collaboration with federal, provincial, territorial jurisdictions, and other data providers.	ECCC	ECCC	Various Data Providers	Spatial		National			Ongoing	Summarize protected and conserved areas across Canada	Contributions from federal, provincial, and territorial governments as well as some local governments, private landowners, and others.	https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas/protected-conserved-areas-database.html#toc1
Wildlife	Terrestrial	Critical Habitat for Species at Risk National Dataset-Canada	This dataset displays the geographic areas within which critical habitat (CH) for terrestrial species at risk, listed on Schedule 1 of the federal Species at Risk Act (SARA), occurs in Canada. Note that this includes only terrestrial species and species for which Environment and Climate Change Canada (ECCC) and Parks Canada Agency (PCA) lead. Under SARA, critical habitat is “the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or action plan for the species.”	ECCC and Parks Canada Agency (PCA)	ECCC, PCA		Spatial		National			Ongoing	Summarizes identified critical habitat for species at risk. The SAR Public Registry should always be considered as the main source for critical habitat information.	Methods for delineating critical habitat are species specific and details can be found in associated recovery documents. In cases where the data are sensitive, the geographic area within which critical habitat occurs may be represented as grids. These are coarse grids (1, 10, 50 or 100 square kilometres) that serve as indicators to locate critical habitat in the recovery planning document.	https://open.canada.ca/data/en/dataset/47caa405-be2b-4e9e-8f53-c478ade2ca74
Landscape Assessment	Planning	Far North Landscape Pattern Analysis, Terrain Analysis and derived eskers and levees	A large suite of map-based and tabular summaries were generated to quantify the composition and spatial patterns of upland features, habitat classes and the relationships between habitat and underlying landscape features (e.g. eskers, levees); Spatial and compositional patterns and trends were identified for the study area, providing a framework for further analysis of avian and other habitat relationships with upland features in the future	ECCC-CWS	ECCC-CWS, Other		Spatial (Shapefile)		transition between Boreal Shield and Hudson Plains	n/a	n/a	complete			Contact ECCC-CWS
Wildlife	Terrestrial	Between Rivers ARU Data	Acoustic recordings of breeding birds and other calling wildlife (e.g. amphibians) from 46 automated recording units (ARUs) located along a 220-km transect across the western side of the James Bay Lowlands EcoRegion, between the Attawapiskat and Albany Rivers.	ECCC-CWS	ECCC-CWS		Excel	estimated counts of individuals by bird species	Between Attawapiskat and Albany Rivers	2019	2019	complete	characterize breeding bird community of James Bay Lowlands	ARUs deployed in late May; retrieved in mid-October. Recording schedule June 1 through mid-July, with daily dawn and dusk periods, plus nocturnal periods.	https://portal.wildtrax.ca/pc/911 or Contact ECCC-CWS
Wildlife	Terrestrial	Boreal Eskers Point Count Data	Breeding bird survey data from 5 road-accessible eskers near the proposed southern end of the N-S transportation corridor.	ECCC-CWS	ECCC-CWS		Excel	estimated counts of individuals by bird species	road-accessible eskers along Ogoki Rd corridor, north/west from Nakina	2014	2014	complete	characterize breeding bird community of eskers along Ogoki Rd	Point Counts conducted in mid-June.	Contact ECCC-CWS
Wildlife	Terrestrial	Ontario Breeding Bird Atlas I, 1981-1985	A five-year province-wide project to document the distribution and abundance of all breeding bird species, repeated every 20 years. The first breeding bird atlas ran from 1981-1985. Data was collected primarily by volunteers. Provides breeding evidence recorded in 100kmx 100km squares in northern Ontario, and 10kmx10km squares in southern Ontario. Data in far northern Ontario, including the RoF region, is biased towards river corridors, as these provided access to the interior of the region.	ECCC-CWS	Partnership	Birds Canada, ECCC-CWS, Ontario Ministry of Natural Resources and Forestry, Ontario Field Ornithologists, and Ontario Nature.	MS Access database	Breeding evidence and occurrence of breeding birds across the province	Ontario	1981	1985	complete	Understand the distribution, range, and population numbers of breeding bird species in Ontario to create a database that forms the basis of management decisions.	Observations of breeding birds in 10 x 10km across Ontario, primarily collected by skilled volunteers.	http://www.birdsontario.org/atlas/index.jsp https://naturecounts.ca/nc/default/explore.jsp#map
Wildlife	Terrestrial	Ontario Breeding Bird Atlas II, 2001-2005	A five-year province-wide project to document the distribution and abundance of all breeding bird species, repeated every 20 years. The second breeding bird atlas ran from 2001-2005. Data was collected primarily by volunteers, but CWS-ON and other partners supplemented volunteer data with targeted survey efforts in some areas including the Far North and the RoF region. Provides point count data to estimate relative abundance birds, as well as breeding evidence recorded in 100kmx 100km squares in northern Ontario, and 10kmx10km squares in southern Ontario. Data in far northern Ontario, including the RoF region, is biased towards river corridors, as these provided access to the interior of the region.	ECCC-CWS	Partnership	Birds Canada, ECCC-CWS, Ontario Ministry of Natural Resources and Forestry, Ontario Field Ornithologists, and Ontario Nature.	MS Access database	Point counts of all species observed, habitat characteristics at each survey location. Square level data, rare species data (images of forms are available which contain information not found in the database) are available from CWS	Ontario	2001	2005	complete	Understand the distribution, range, and population numbers of breeding bird species in Ontario to create a database that forms the basis of management decisions.	Point counts and observations of breeding birds in 10 x 10km across Ontario, primarily collected by skilled volunteers.	http://www.birdsontario.org/atlas/index.jsp https://naturecounts.ca/nc/default/explore.jsp#map

Wildlife	Terrestrial	Northern Ontario Waterfowl Plot Survey	Aerial waterfowl survey targeting early nesting ducks; includes Canada geese, some waterbirds and some shorebirds. Ontario-wide surveys were carried out between 1980 and 2007, but in the RoF region, no surveys have been conducted since 1990.	ECCC-CWS	ECCC-CWS		MS Access database	counts of waterfowl by species	Ontario	1980	2007	complete	Estimate density of early nesting duck species	Helicopter survey; 2km x 2km square plots; all wetlands, waterbodies, rivers surveyed	Contact ECCC-CWS
Wildlife	Terrestrial	Ring of Fire Waterfowl Survey	CWS, from 2022 – 2025, will conduct aerial surveys to obtain baseline information / data on breeding season abundance and distribution of early- and late-nesting waterfowl (ducks, geese and swans) and waterbird (Sandhill Cranes, loons, gulls, herons, terns, etc) in anticipation of the Ring of Fire Regional Assessment. Information obtained from this work also will provide data for the 3rd Ontario Breeding Bird Altas (2021 – 2025) that is undertaken every 20 years in Ontario. The surveys will entail flying a series of pre-selected, randomly chosen 5 km x 5 km plots containing appropriate habitats for these species throughout the spring breeding season (May – late-June / early-July) within the Ring of Fire Regional Assessment area.	ECCC-CWS	ECCC-CWS		Spatial (geodatabase) & Excel	Counts or visual estimates of individuals in flocks.	Northcentral Ontario, Boreal Forest and Hudson Bay Lowlands. Specially, data collected within 50 km buffer of N/S proposed road corridor and 100 km buffer of the core RoF mining claims. As well as to the north of the mining claims to the Hudson Bay coastline (vicinity of Peawanuck, Ontario).	2022	2025	ongoing	Estimate density of early nesting and late nesting duck species and distribution within the defined study area. Incidental observations also recorded of other bird and mammal species outside of survey plots.	Helicopter survey; 5km x 5km square plots; all wetlands, waterbodies, rivers surveyed	Contact ECCC-CWS
Wildlife	Terrestrial	Ontario Breeding Bird Atlas – III, 2021-2025	Data collection for the Ontario Breeding Bird Atlas 3 (Atlas-3) began on January 1, 2021 and will end December 31, 2025. Volunteer birders will count and record the presence of breeding birds across all of Ontario for five years. Atlas- 3 is a partnership between the same five organizations as Atlas-2. Volunteers are central to the success of the Atlas. This enormous project is achievable only through the mass participation of the province's birders. It shows what the birding community can accomplish when we work together with a single purpose.	ECCC-CWS	Partnership	Birds Canada, Canadian Wildlife Service (Environment and Climate Change Canada), Ministry of Natural Resources (Government of Ontario, Ontario Field Ornithologists (OFO), and Ontario Nature			Point counts of all species observed, habitat characteristics at each survey location	2021	2025	ongoing	The goal of the Atlas is to map the distribution and relative abundance of Ontario's approximately 300 species of breeding birds – from as far south as Middle Island in Lake Erie, to Hudson Bay in the north.	Point counts, checklists, Recorded point counts, long term ARU deployments. Primary volunteers, but partner organizations also submit their data for inclusion.	birdsontario.org https://naturecounts.ca/nc/default/explore.jsp#map
Wildlife	Terrestrial	Northern Ontario Caribou Fecal DNA Surveys	Aerial winter distribution surveys and collection of fecal pellets across the provincial boreal caribou Missisa Range in 2021 and 2025, Ozhiski Range in 2022, James Bay Range in 2023, and Nipigon and Pagwachuan Ranges in 2024. Aerial winter (February and/or March) distribution surveys conducted by fixed-wing aircraft and targeted fecal pellet collection by helicopter.	ECCC-CWS	ECCC-CWS, Trent University	Trent University, ECCC-WLSD	Spatial (geodatabase)	Counts of all species observed during aerial survey. & DNA data & hormone concentration data, pregnancy status of females	Sites located in and around Ring of Fire mining claims area including the Missisa, Ozhiski, James Bay, Nipigon, and Pagwachuan ranges.	2021	2025	Ongoing	Estimate caribou abundance in the region as well as collect samples for subsequent analysis of genetic information as well as pregnancy rates and stress levels through hormonal analysis.	Aerial distribution surveys and collection of fecal pellets.	Contact ECCC-CWS
Wildlife	Terrestrial	Bat acoustic surveys in Ring of Fire region	Incidental deployment of bat ARUs in the RoF region to collect bat observations. Data collected nightly during June to September survey window using SM4Bat recording units.	ECCC-CWS	ECCC-CWS		Excel		Sites located near Ring of Fire mining claims area.	2021	2026	Ongoing	Gain a baseline understanding of existing bat populations, species' habitat requirements, and anticipated threats to bats in the region.	Deployment of bat ARUs	https://www.nabatmonitoring.org/

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Wildlife	Terrestrial	Wolf Acoustic Surveys in the Ring of Fire Region	Dataset of wolf acoustic recordings collected from autonomous recording units (ARUs) deployed across Ontario's Far North. Sampling period is March - September	ECCC-CWS	ECCC-CWS		Excel		Sites located in and around Ring of Fire mining claims area.	2019	2026	Ongoing	Collection of baseline predator data in Ring of Fire Region that can be used to assess caribou's predation risk in the region.	Visual scanning of acoustic spectrograms	Contact ECCC-CWS
Wildlife	Terrestrial	Remote camera trap deployments in Ontario's Far North	Remote camera trap deployment began in 2022 across Ontario's Far North, with the focus being for wolves, Boreal and Eastern Migratory Caribou.	ECCC-CWS	ECCC-CWS, Wilfred Laurier University	ECCC-WLSD, Wilfrid Laurier University, University of Guelph, Four Rivers Environmental (Matawa Tribal Council), Natural Resources Canada	Excel;Spatial		Sites located in and around Ring of Fire mining claims area.	2022	2026	Ongoing	Collect data on caribou, and caribou predators for the purpose of evaluating predation risk for boreal caribou. Data on other wildlife, including wolverine and moose is also captured by the cameras	Deployment, retrieval and/or refreshment of remote recorders (trail cameras)	Contact ECCC-CWS
Wildlife	Terrestrial	Acoustic surveys in Ring of Fire region – eastern lowlands	Deployment of ARUs in Ontario's Far North to collect observations of migratory songbirds and other incidentally observed species. Recordings conducted 2021-2025 ~~Deployment began in 2021 with further deployments in 2022, 2023, and 2024.~~	ECCC-CWS	ECCC-CWS		Spatial (geodatabase) & Excel & Audio recordings		Sites located near Ring of Fire mining claims area.	2021	2026	Ongoing	Collection of acoustic information in Ring of Fire to assess abundance and distribution of migratory songbirds and other species	Deployment, retrieval, and interpretation of autonomous recording units (ARU)	Interpreted recordings: https://portal.wildtrax.ca/discover
Wildlife	Terrestrial	Boreal Burns ARU Data	Acoustic recordings of breeding birds and other calling wildlife (e.g. amphibians) from automated recording units (ARUs) located in a randomly-dispersed selection boreal burns (1-20 years post-fire), across a central-western sub-region of Ontario's Far North. Acoustic interpretations of the dawn and dusk bird community are available. Targeted interpretation was also done to characterize temporal patterns of common nighthawk and olive-sided flycatcher.	ECCC-CWS	ECCC-CWS		Excel	estimated counts of individuals by bird species	central-western sub-region of Ontario's Far North	2012	2012	complete	characterize breeding bird community of boreal burns; model temporal patterns of common nighthawk and olive-sided flycatcher	ARUs deployed in late May; retrieved in mid-September. Recording schedule June 1 through mid-August, with regular dawn and dusk periods, plus nocturnal periods.	Contact ECCC-CWS
Wildlife	Terrestrial	Boreal Colonial Waterbird Surveys	Aerial and Boat Surveys of Boreal Lakes in Northwestern Ontario for Colonial Waterbirds and other incidental species nesting at these locations.	ECCC-CWS	ECCC-CWS		Excel	Habitat availability and breeding waterbird counts	central-western sub-region of Ontario's Far North including Lake St. Joseph	2010	2012	complete	Population and distribution surveys of colonial waterbirds in the boreal forest	Aerial and boat surveys	Contact ECCC-CWS
Wildlife	Terrestrial	Boreal Lake Water Clarity	Water Clarity Raster derived from LandSat Imagery of Boreal Lakes.	ECCC-CWS	CWS-contractor		Raster			2014	2014	complete			Contact ECCC-CWS
Wildlife	Terrestrial	Boreal Wetland Bird Surveys ARU Data	Acoustic recordings from ARUs located in a randomly-dispersed selection of boreal wetlands, across a central-western sub-region of Ontario's Far North. Acoustic interpretations of the dawn and dusk bird community and DIY air photos taken by helicopter pilot and used to quantify habitat composition are available.	ECCC-CWS	ECCC-CWS		Excel, jpeg	estimated counts of individuals by bird species, geo-referenced air photos	central-western sub-region of Ontario's Far North	2013	2013	complete	characterize breeding bird community of sedge- dominated boreal wetlands, document habitat conditions at time of bird sampling	ARUs deployed in late May; retrieved in mid-September. Recording schedule June 1 through mid-August, with regular dawn and dusk periods, plus nocturnal periods. DSLR mounted vertically to floor of helicopter cabin, aimed orthogonally to the ground through	Contact ECCC-CWS

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														the pilot's long-line window. Pilot hovered at 2,000' a.g.l. above each ARU station, and captured several photos using a remote trigger.	
Wildlife	Terrestrial	Hudson Bay Lowlands Shorebird Survey 2005	Pilot study to test aerial survey methods for generating breeding shorebird population indices. All wildlife observed was recorded in addition to breeding shorebirds	ECCC-CWS	CWS-partnership	OMNRF	Excel	Numbers of shorebirds	Hudson Bay lowlands	2005	2005	complete	develop methods to estimate breeding density of shorebird species in peatland habitat	Helicopter aerial survey of counts within fixed width strip transects (individuals & nests) along transects.	Contact ECCC-CWS
Wildlife	Terrestrial	Lesser Yellowlegs Tracking Project	The study involved: 1. Deploy GPS Argos PinPoint and geolocator tags on breeding adults to identify migratory timing and routes, including key stopover sites and wintering locations utilized by individual Lesser Yellowlegs within sub-populations in Alaska and Canada. 2. Individually mark and resight individual Lesser Yellowlegs to estimate apparent annual survival rates. 3. Collect biological samples to examine potential genetic variation in sub-populations of Lesser Yellowlegs. Collect information on reproductive rates of Lesser Yellowlegs to better understand nest and brood survival, and juvenile recruitment.	ECCC-CWS	CWS-partnership	OMNRF	Other	migration tracks, annual survival rates	sites across Canada and Alaksa including James Bay	2018	2019	Complete	The study aimed to fill knowledge gaps and investigate the causes of declines for Lesser Yellowlegs, which includes unregulated hunting on wintering grounds.	GPS Argos PinPoint and geolocator tags	https://www.movebank.org/cms/webapp?gwt_fragment=page=studies,path=study543061768 See references for publication links
Wildlife	Terrestrial	James Bay Shorebird Project	A partnership to survey southbound staging shorebirds. This work initially included surveys at sites known to support staging shorebirds, with an emphasis on Red Knot (C. canutus rufa) to enable identification of critical habitat, as well as surveys for two federal Species at Risk, the Yellow Rail (Coturnicops noveboracensis) and Short-eared Owl (Asio flammeus). Additional work to collect natural heritage information has been conducted in concert with more recent surveys. Currently, the project involves annual surveys of shorebirds staging at established survey sites along the southwestern coast of James Bay. The goals of the project are to: • Produce reliable estimates of shorebird species staging along the south-western James Bay coast; • understand local and flyway scale movement patterns of shorebirds staging in James Bay; and • identify sites and habitats needed to sustain staging shorebirds. The objectives to meet these goals are to estimate the: • variability in shorebird migration phenology (both annually and among species); • length of stay of staging shorebirds; • annual variation in the abundance of staging shorebirds; • habitat and food resource availability for staging shorebirds; and • minimum proportion of the global Red Knot, subspecies rufa, population that uses the southwestern James Bay coast.	ECCC-CWS	CWS-partnership	OMNRF, Royal Ontario Museum, ECCC-STB	MS Access database	estimated counts of shorebird individuals by species, tag detections and flag resightings, bird banding data, effort data, incidental species sightings, red blood cell inventory,	James Bay coast	2009	2019	Paused variable	The overall objective of the project is to contribute to shorebird population assessments and conservation, site designations and protection (e.g. Important Bird Area and WHSRN), and species recovery and protection (e.g. Endangered rufa Red Knot , other declining shorebirds).	ground and aerial-based flock counts, re-sighting of unmarked birds, MOTUS	https://www.jamesbayshorebirdproject.com https://www.ebird.org See references for publication links
Wildlife	Terrestrial	Hudson Bay & James Bay Moulting Scoter Survey	Aerial-photographic survey of scoters (primarily male black scoter) along the Hudson Bay Coastline of Ontario.	ECCC-CWS / OMNRF	ECCC- CWS Partnership, CWS holds data	ECCC-CWS, OMNRF	Geodatabase	Counts or visual estimates of individuals in flocks.	Hudson and James Bay coastline (0 - 15 km offshore) of Ontario.	1977	2013	Periodic, ongoing	Abundance and distribution of moulting scoters along Hudson / James Bay coastline of Ontario.	Aerial (fixed-wing aircraft), cruise-style survey along coastline (0 - 15 km offshore) using aerial photographic and visual estimation methods to determine abundance and distribution of moulting scoters (primarily Black Scoter, few Surf	Contact ECCC-CWS

Category	Subcategory	Title	Description	Primary Contact Type (Dept, Branch, Ministry, FN, Other)	Ownership	Partners	Format	Parameters	Spatial Coverage	Time Period - Start	Time Period - End	Status	Study Objectives	Method	Means to access
														Scoter and White-winged Scoter).	
Wildlife	Terrestrial	Ontario Clay Belt Waterfowl Survey	The Clay Belt is a unique region in the boreal forest having a rich clay soil in contrast to the low fertility habitats of the muskeg and exposed-bedrock shield surrounding it. This higher fertility of the Clay Belt is evidenced by higher rates of wetland occupancy by waterfowl than in the adjoining areas. This waterfowl study was initiated in part to assist in the planning of wetland conservation efforts by Ducks Unlimited Canada [DUC] in the Clay Belt of northeastern Ontario, which had been identified as a Key Program Area through the Eastern Habitat Joint Venture.	ECCC-CWS / OMNRF	ECCC – CWS Partnership, CWS holds data	ECCC-CWS, OMNRF, DUC	MS Access database	Counts of singles, pairs, flocks (sex and age identification, to extent possible) and brood surveys	Great Claybelt region of northeastern Ontario	1988	1990	Complete	Objectives: (1) to determine species composition, density, and distribution of the waterfowl community, (2) to determine habitat correlates of nesting and brood-rearing waterfowl, and (3) to develop a wildlife habitat map using LANDSAT.	Aerial (helicopter), plot-based (141, 2 km x 2 km plots) survey of potential waterfowl breeding habitats in the Great Claybelt in northeastern Ontario. Different survey years, timed for early or late nesting waterfowl as well as brood surveys.	Contact ECCC-CWS
Wildlife	Terrestrial	James Bay & Hudson Bay Migrant Waterfowl Survey	Migrant Waterfowl Surveys provide periodic data on spring- and fall-migrant waterfowl abundance, spatial and temporal distributions, and use along the shorelines of the Great Lakes and Hudson / James Bay in Ontario. Surveys for waterfowl and other non-target avian species (shorebirds, gulls, waterbirds, etc.) have been conducted between spring and fall along the Ontario coastline and nearshore waters of Hudson & James Bay (Spring 1977, 1978, 1990 & 1995; Summer 1977 – 1979, 1985, 1990, 1991, 1995, & 1997; Fall 1976 – 1981, 1990 – 1995, 1998 & 2001).	ECCC-CWS	ECCC-CWS CWS holds data	NA	Geodatabase	Counts or visual estimates of individuals in flocks.	Hudson and James Bay coastlines of Ontario.	1977	2001	Periodic, ongoing	Abundance and distribution of migrant waterfowl along coastlines of Ontario.	Aerial (fixed-wing aircraft), cruise-style survey conducted within survey sectors where visual estimation is used to determine abundance of waterfowl species (and other waterbird species).	Contact ECCC-CWS
Wildlife	Terrestrial	Eastern Waterfowl Survey (in part Waterfowl Breeding Population & Habitat Survey)	Provides annual data on abundance, geographic distribution, trends and population estimates of breeding waterfowl species in eastern North America (primarily southern portions and boreal forest regions of Ontario, Quebec & Atlantic provinces).	ECCC-CWS	ECCC- CWS Partnership, CWS holds data	ECCC- CWS, USFWS, Atlantic Flyway States & Provinces	MS Access database	Counts of singles, pairs, flocks (sex and age identification, to extent possible)	Boreal portion of northcentral Ontario	1996 (some plots, 1996 – 2015)	Present	Annual, ongoing	Provides annual information on the population status of waterfowl in eastern North America to aid in conservation and harvest management decisions in Canada and the US.	Aerial (helicopter), plot-based (5km x 5 Km) survey of potential waterfowl breeding habitats in mixed wood & boreal forest regions within Ontario, Quebec & Atlantic provinces (i.e., the Eastern Survey Area).	Contact ECCC-CWS
Wildlife	Terrestrial	Waterfowl Breeding Population & Habitat Survey	Provides annual data on abundance, geographic distribution, trends and population estimates of breeding waterfowl species in much of northern North America (primarily Ontario [including northern and western regions], the US Prairie Pothole Region, Prairie, Pacific and Northern Canadian provinces & Alaska).	USFWS / ECCC-CWS	ECCC- CWS Partnership, USGS / USFWS	ECCC- CWS, USFWS, Mississippi, Central & Pacific Flyway States & provinces	Geodatabase	Counts of singles, pairs, flocks (sex and age identification, to extent possible)	Boreal and Hudson Bay Lowlands portion of northern Ontario	1955 (some strata, 1996 – 2010)	Present	Annual, ongoing	Provides annual information on the population status of waterfowl in eastern North America to aid in conservation and harvest management decisions in Canada and the US.	Aerial (fixed-wing aircraft), transect-based survey (series of transects distributed within numerous survey strata) through potential waterfowl breeding habitats within major waterfowl breeding areas throughout North America (i.e., the Traditional Survey Area).	Contact USFWS; https://www.fws.gov/project/waterfowl-breeding-population-and-habitat-survey
Wildlife	Terrestrial	Canada Goose Breeding Surveys - Southern Hudson Bay Population	Aerial transect-based survey of Canada Geese within the Hudson / James Bay Lowlands (incl. Akimiski Island, Nunavut) of Ontario and Manitoba. Formerly individual surveys for former SJBP, MVP and EPP Canada Goose Populations. Survey design has been altered over time as goose populations were amalgamated for management purposes. Most recent survey design change in 2016.	OMNRF / ECCC-CWS	ECCC- CWS Partnership, OMNRF	ECCC-CWS, OMNRF, Mississippi Flyway States & Provinces, USFWS	Excel	Counts or visual estimates of individuals.	James Bay & Hudson Bay Lowlands and coastline (including Akimiski Island, Nunavut) of Ontario as well as Manitoba.	1989	present	Annual, ongoing	Abundance and distribution of breeding population of Canda Geese nesting in the Hudson	Aerial (fixed-wing aircraft), transect-based survey of visual estimates / counts of Canada Geese (individuals & nests) and other waterfowl / other incidental avian	Contact OMNRF

Category	Subcategory	Title	Description	Primary Contact Type (Dept, Branch, Ministry, FN, Other)	Ownership	Partners	Format	Parameters	Spatial Coverage	Time Period - Start	Time Period - End	Status	Study Objectives	Method	Means to access
													/ James Bay Lowlands of Ontario.	species.	
Wildlife	Terrestrial	Cape Henrietta Maria Snow Goose Colony Surveys	Aerial photo survey of Snow Geese pairs / nests at Cape Henrietta Maria on Hudson Bay Coastline of Ontario.	OMNRF / ECCC-CWS	ECCC- CWS Partnership, OMNRF	OMNRF, ECCC-CWS	Excel	Counts or visual estimates of individuals (pairs) or nests.	Cape Henrietta Maria lesser snow goose colony in Polar Bear Provincial Park along the Hudson & James Bay coastlines of Ontario.	1969	2019	Periodic, ongoing	Abundance (pair / nests) and distribution of nesting snow geese at Cape Henrietta Maria.	Aerial (fixed-wing aircraft), survey of visual estimates / counts or photo counts of snow geese (individuals & nests) along transects.	Contact OMNRF
Wildlife	Terrestrial	Hudson Bay Lowlands Breeding Scoter Survey	Aerial survey (one-time) of scoters breeding inland from the Hudson Bay coastline of Ontario.	OMNRF / ECCC-CWS	ECCC- CWS Partnership, OMNRF	OMNRF, ECCC-CWS	Geodatabase	Counts of singles, pairs, flocks (sex and age identification, to extent possible)	Hudson Bay Lowlands south of Peawanuck in the Winisk River region Ontario (area: 10,000 km^2).	2009	2009	Completed	Abundance, distribution and habitat use of breeding scoters (Black, Surf and White-winged) within the Hudson Bay Lowlands in the Far North of Ontario.	Aerial (helicopter), transect-based survey inland from the Hudson Bay coastline (~15 – 250 km) using visual counts of birds in various distance bands from the aircraft along transects within suspected breeding habitat for scoters species.	Contact OMNRF
Wildlife	Terrestrial	Southern Hudson Bay Population Canada Goose Banding Program	Banding during summer (June/July) of flightless adults and pre-fledged young along the James Bay and Hudson Bay coastlines (including Akimiski Island, Nunavut) of Ontario. To determine broadscale movements, seasonal habitat use, migration routes, harvest rates, survival rates, productivity of Canada geese.	OMNRF / ECCC-CWS	ECCC- CWS Partnership, OMNRF	ECCC-CWS, OMNRF, Mississippi Flyway States & Provinces, USFWS	Banding database, housed by USGS Bird Banding Laboratory & CWS Bird Banding Office (seek OMNRF permission for access)	Mark / Recapture data of leg banded birds via recapture, resighting or recovery of birds (found dead or harvested during hunting season)	James Bay & Hudson Bay (including Akimiski Island, Nunavut) coastline of Ontario.	1989	present	Annual, ongoing	To determine broadscale movements, seasonal habitat use, migration routes, harvest rates, survival rates, productivity of Canada geese (primarily of those belonging to Southern Hudson Bay Population).	Broad-scale mark-recapture program using aluminum leg bands to mark adult and pre-fledged young during the summer (June/July) when birds are flightless.	Contact OMNRF
Wildlife	Terrestrial	James Bay and Hudson Bay Snow Goose Banding Program	Banding during summer (June/July) of flightless adults and pre-fledged young along the James Bay and Hudson Bay coastlines (including Akimiski Island, Nunavut) of Ontario. To determine broadscale movements, seasonal habitat use, migration routes, harvest rates, survival rates, productivity of Lesser Snow geese.	OMNRF / ECCC-CWS	ECCC- CWS Partnership, OMNRF	OMNRF, ECCC-CWS	Banding database, housed by USGS Bird Banding Laboratory & CWS Bird Banding Office (seek OMNRF permission for access)	Mark / Recapture data of leg banded birds via recapture, resighting or recovery of birds (found dead or harvested during hunting season)	James Bay & Hudson Bay (including Akimiski Island, Nunavut) coastline of Ontario.	1989	present	Annual, ongoing	To determine broadscale movements, seasonal habitat use, migration routes, harvest rates, survival rates and productivity of Lesser Snow geese.	Broad-scale mark-recapture program using aluminum leg bands to mark adult and pre-fledged young during the summer (June/July) when birds are flightless.	Contact OMNRF
Wildlife	Terrestrial	The Atlantic & Great Lakes Sea Duck Migration Study – Long-tailed Duck Satellite Telemetry Data	Satellite telemetry data from Long-tailed Duck captured at Lake Ontario and tracked throughout their annual cycle (winter, spring/fall staging and breeding locations); data on other sea duck species (Black Scoter, Surf Scoter & White-winged Scoter) may be available upon request to SDJV & partners.	ECCC-CWS	ECCC-CWS Partnership, Biodiversity Research Institute [BRI]	Sea Duck Joint Venture Partners (See Acknowledgements)	Geodatabase	Satellite-telemetry based location data	Atlantic coastline of US, US & CDN Great Lakes region & Hudson / James Bay & eastern Arctic Canada.	2011	2012	Complete	Track migration movements and seasonal habitat use of Sea Ducks (Long-tailed Duck, Black Scoter, Surf Scoter and White-winged Scoter) in eastern	Satellite telemetry tracking of individuals captured at wintering areas in eastern North America (US and Canada: Great Lakes & Atlantic coast).	Contact SDJV: https://seaduckjv.org/science-resources/atlantic-and-great-lakes-sea-duck-migration-study/

Category	Subcategory	Title	Description	Primary Contact Type (Dept, Branch, Ministry, FN, Other)	Ownership	Partners	Format	Parameters	Spatial Coverage	Time Period - Start	Time Period - End	Status	Study Objectives	Method	Means to access
													North America.		
Wildlife	Terrestrial	The Black Duck & Eastern Mallard Telemetry Study	Satellite telemetry data from American Black Duck and Mallards captured in eastern North America (Atlantic Flyway [AF] States & Provinces, including Ontario) and tracked throughout their annual cycle.	ECCC-CWS	ECCC-CWS Partnership, Ornitrack - Ornitela	ECCC-CWS, USFWS, AF States & Provinces, University of Saskatchewan	Geodatabase	Satellite-telemetry based location data	Atlantic US states & provinces along with Great Lakes region, Ontario boreal & Hudson Bay Lowlands of Canada.	2022	2026	Annual, ongoing	Track migration movements and seasonal habitat use of American Black Ducks & Mallards in eastern North America	Satellite telemetry tracking of individuals captured at wintering areas in eastern North America (US and Canada: Great Lakes region & Atlantic coast).	Contact ECCC-CWS

CWS-ON Interim Report on Biodiversity in the Ring of Fire Region – Cumulative Effects (WLSD)

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Acknowledging and addressing limitations of efforts to project the cumulative effects of development scenarios and natural disturbance on wildlife and wildlife habitat in the Ring of Fire region

AUTHORS: JOSIE HUGHES & CATHERINE DIELEMAN (PROVIDING A BRIEF OVERVIEW OF WORK DONE BY MANY)

Introduction

In anticipation of requests for science advice regarding cumulative effects associated with the Regional Assessment in the Ring of Fire (RoF) area, the ECCC Wildlife and Landscape Science Directorate (WLSD) led an effort (Feb 2020 to Spring 2022) to assess the usefulness of available modeling tools for projecting cumulative effects of natural disturbance and human activities on migratory birds and boreal caribou in the RoF region. The project involved collaboration among researchers and biologists from WLSD, NRCan-Canadian Forest Service (CFS), ECCC-Canadian Wildlife Service-Ontario Region (CWS-ON), the University of Guelph, Wilfrid Laurier University, the Laval University, and the University of Alberta Boreal Avian Modeling project, and consultants from FOR-CAST Research & Analytics and Apex Resource Management Solutions Ltd (supported in part by GCXE21S046, GCXE21S047, GCXE22S048, and GCXE23S015).

The study area for the work was defined by scientists and biologists at WLSD, CWS and NRCan before the development of the draft Terms of Reference for the RoF Regional Assessment (Figure 0-1). The cumulative effects project was divided into five elements (Figure 0-2): (A) fire and forest succession modelling, (B) boreal caribou resource selection and demographic modelling, (C) boreal bird distribution modelling, and (D) a model integration and user interface framework to integrate elements A-C for cumulative effects assessment and enable non-programmers to explore anthropogenic disturbance scenarios.

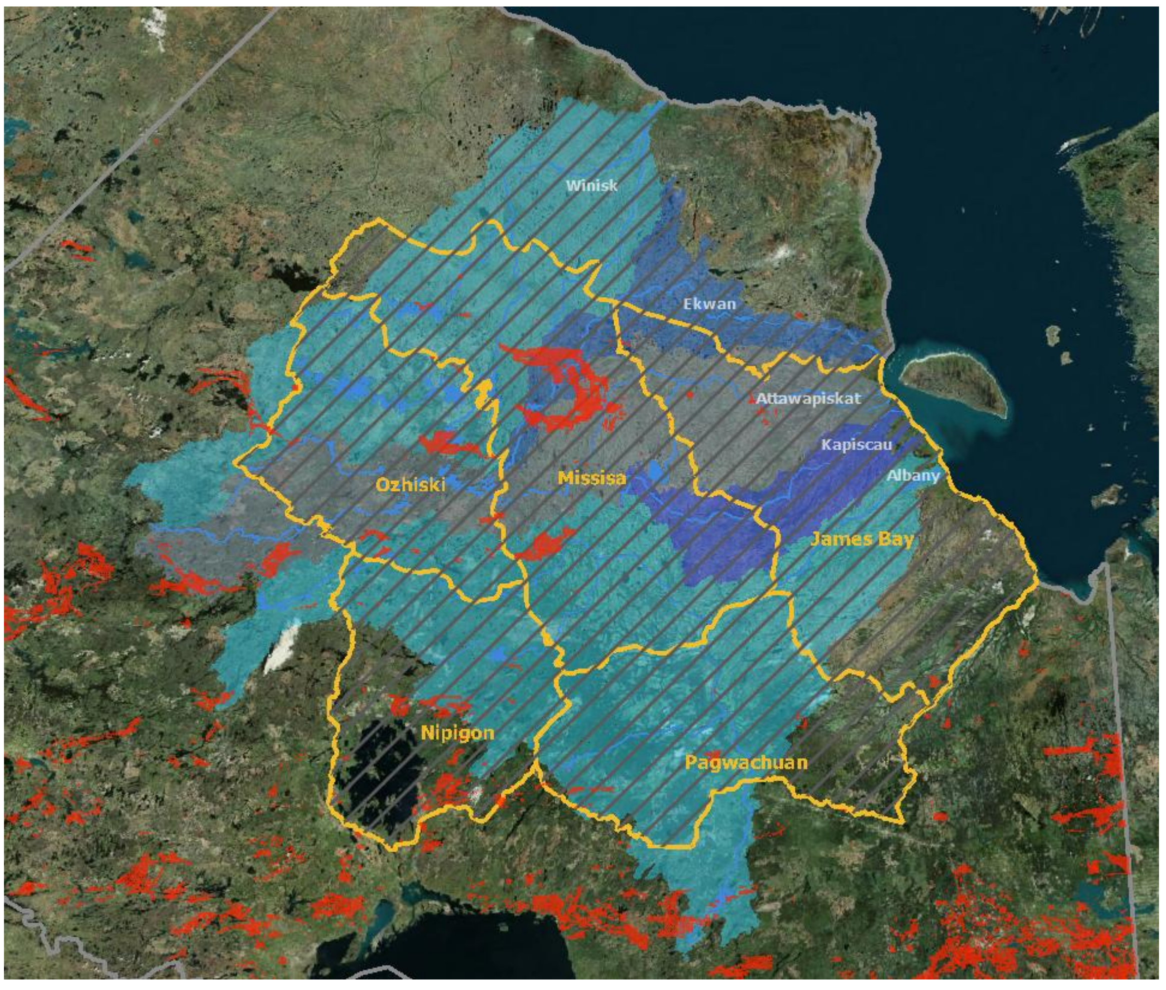

Figure 0-1 Watersheds (blue and grey), boreal caribou ranges (yellow), and mining claims (red; MNDMNRF, 2022) of the region. For modelling cumulative effects, we define the Ring of Fire (RoF) projection region (grey hash) to include the Missisa boreal caribou range and the four caribou ranges adjacent to it, and portions of the Winisk and Ekwan watersheds that are downstream from the RoF mining claims. Bird models were run for the whole projection region, and boreal caribou models for all five ranges are available in the user interface, but we investigated the behaviour of the caribou in the Missisa range

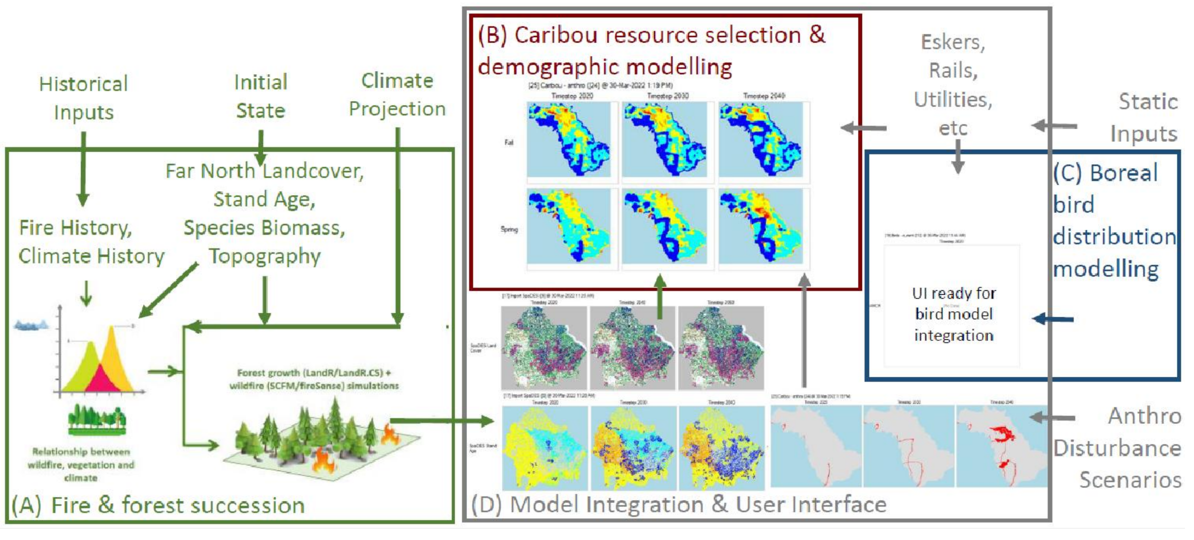

Figure 0-2 Relationships among cumulative effects project elements. The model integration and user interface (D) framework combined projections of age and land cover from the fire and forest succession model (A) adapted from the Western Boreal (Micheletti et al., 2023, 2021; Stewart et al., 2023) with static inputs

(e.g., eskers), anthropogenic disturbance scenarios and caribou resource selection and demographic models (B). The integration and user interface (D) framework was also designed to integrate boreal bird distribution models (C) or other wildlife response models.

The project highlighted a number of important deficits in wildlife models available at that time; none were suitable for projecting cumulative effects of disturbance in the region. Since 2022 there have been changes in both the available models and the data used to inform them, so our 2022 assessment is no longer current. This chapter provides a brief overview of currently available boreal caribou and bird modeling tools, ongoing efforts to improve them, (some) remaining challenges for reliable quantitative projection of cumulative effects to inform decisions in the region, and possible next steps in our efforts to develop and sustain environmental monitoring partnerships in the region.

Caribou resource selection and demographic modelling

We assessed two existing models of Ontario caribou resource selection (Hornseth and Rempel, 2016; Rempel and Hornseth, 2018) and demography (Johnson et al., 2020), and found that neither model was well suited for projecting cumulative effects of development on boreal caribou in the Ring of Fire region (Dyson et al., 2022).

The specificity of the available resource selection model to current conditions limits its usefulness for predicting impacts, and high variability in the model coefficients among caribou ranges suggests that habitat selection varies with habitat availability. There is very little relevant disturbance history in the Ring of Fire region, so it is necessary to borrow information from other areas to project the impacts of disturbance. However, there are also important ecological differences between the Hudson Plains and the Boreal Shield ecozones. There is a need for new models designed for projection that allow borrowing of information from other areas while also accounting for variation in habitat selection. WLSD has made no efforts to develop new caribou resource selection models for northern Ontario because relevant caribou telemetry data was only recently (spring 2025) made available to us. However, CFS has ongoing efforts developing caribou habitat selection models relative to cumulative disturbances that are forecastable to aid in decision-making processes. To date, the work has been done in the western boreal, but new efforts are expanding these models to Ontario and assessing the “natural” and future ranges of variation in behavior under different land-use and climate change scenarios in the region.

To improve our ability to project boreal caribou population viability on changing landscapes we developed a Bayesian method for integrating national demographic-disturbance relationships and local data (Hughes et al., 2025). Others have proposed Bayesian analysis methods that do not include impacts of changing disturbance (e.g. Dalgarno et al., 2024). There is relatively little available demographic data for boreal caribou populations in the Ring of Fire region (MNRF, 2014a, 2014b, unpublished). Analysis of the available demographic data using relevant Bayesian methods would help clarify how much uncertainty remains about the current status of these populations and their vulnerability to proposed development. Caribou demographic data continues to be collected in the region, and regular (e.g. annual) updates to this analysis will be necessary for making best available information available to inform decisions. Adoption of Bayesian demographic analysis methods would be a useful first step toward a more formal approach to analysis of the value of additional data collection that targets key data gaps and considers efficient use of available resources, as recommended in the “Scientific assessment of federal and provincial frameworks for the conservation of boreal caribou in Ontario” (ECCC, 2024).

Working together to improve the reliability and utility of Northern Ontario bird models for decision making

The regional boreal bird species distribution and abundance models included in our 2022 reporting were developed using a limited dataset of point count landbird data collected between 1996 and 2019. Since then, CWS-ON and other contributors to the province-wide 3rd Ontario Breeding Bird Atlas (2021-2025) have made substantial efforts to collect more fully representative northern Ontario landbird data (see Section 3 for details). The new data is being used to inform regional, provincial and national-scale bird models designed to meet a variety of information needs.

In late 2023, Josie Hughes (WLSD) and Russ Weeber (CWS-ON) convened the Northern Ontario Bird Modeling Working Group (NOBMWG), an informal initiative that brings together experts from federal and provincial governments, academia and environmental non-government organizations with expertise in statistical modeling, northern Ontario birds and bird habitats, and those who incorporate bird model outputs into financial, human resource and survey decisions. Broadly, the working group aims to support efficient use of the emerging bird dataset and the development, evaluation, and appropriate use of models for northern Ontario birds.

Although we expect that models informed by the new data will be more reliable, the Ring of Fire region is vast, heterogeneous and remains sparsely sampled; many aspects of modeling are expected to remain uncertain. Experience with the use of bird models in decision processes has clarified that understanding and communicating uncertainty in this data sparse region is essential to reliable decision making, and that there are risks associated with misuse and misinterpretation of large scale (national or provincial) bird modeling results in regional and local assessments. Supported by WLSD (GCXE25S033) and informed by working group members, the Alberta Biodiversity Monitoring Institute is leading development of tools to support model evaluations and the appropriate use and interpretation of bird model products for informing decisions in the Hudson Bay Lowlands and other sparsely sampled regions. Anticipated outcomes include: a prototype system for soliciting and synthesizing feedback on species distribution models from species experts and statistical reviewers; communication tools and guidance on how to use models and their reliability as inputs to evaluating and communicating biodiversity co-benefits, conducting cumulative effects estimations, predicting impacts, and supporting decisions pertaining to species at risk and migratory birds. The project will also develop and communicate methods to incorporate model reliability into an adaptive modelling framework to improve model products.

Working group members will use a variety of quantitative methods for model evaluation and comparison, and will continue to integrate new information into models as it becomes available. We expect that an iterative process of model development, evaluation, refinement and interpretation using a variety of methods will continue to improve the reliability and usefulness of bird models in northern Ontario.

Vegetation

There is a rich history of spatial-stochastic models for projecting wildfire occurrence and spread, and forest succession under climate change scenarios (Figure 7-2A) (Sturtevant and Fortin, 2021). In other regions these models can be linked with wildlife habitat models to forecast future wildlife distribution and abundance (Barros et al., 2023; Bouderbala et al., 2022; Hof et al., 2021; Labadie et al., 2023; Leblond et al., 2022; Micheletti et al., 2023, 2021; Stewart et al., 2023; Tremblay et al., 2018). Assessment (unpublished 2021 analysis) of the transferability and utility of Western Boreal Initiative (Micheletti et al., 2023, 2021; Stewart et al., 2023) fire and forest growth and succession models for the RoF region highlighted important deficits, inconsistencies and errors in available (circa 2021) fire and vegetation (tree species composition, age, and species-specific tree biomass potential) data for the Hudson Plains ecozone.

Since 2021 a number of newer remote sensing data products have been developed (e.g. Wulder et al., 2025), and more are in development. It remains challenging for developers of wildlife response models to assess the usefulness and reliability of these data products in the Ring of Fire region. We anticipate that ongoing efforts to develop, evaluate and compare bird models using a variety of methods (Section 7-3) will yield some additional insights into strengths and limitations of available remote sensing data products.

Spatial variation in vegetative community composition and associated primary productivity within the region remains poorly understood, in part due to limited availability of ground plot data from parts of the landscape that are difficult to access. In the summer of 2024 partners at the University of Guelph and Wilfrid Laurier University began addressing this knowledge gap by quantifying overstory, understory, and ground layer vegetative communities at 30 of the CWS plot network locations near Napken Lake. At each site, 30 m x 30 m study sites were established, bisected by a 30 m transect oriented north to south. The understory and ground layer vegetation were assessed to species using five evenly spaced 1 m x 1 m assessment plots. The overstory was characterised using a 2 m x 30 m belt transect, identifying all trees over 1.5 m in height to species. 114 unique understory species were observed across the 150 vegetation assessment plots established in the region. These plots could be revisited in future to assess change. Reference specimens were collected across the site network for 81 plant species and are actively being prepared for long-term storage with the Museum of Nature as part of their broader Hudson Bay Lowlands herbarium collection. Vegetation sampling will continue in summer 2025. These data will provide baseline information on vegetative community composition in the region.

To characterize vegetation across the larger network of camera trap deployments in the region, Wilfrid Laurier University (supported by WLSD GCXE24S071, NSRC and CFS) has led development of a reproducible method for analyzing vegetation site photos. Analysis of associations among vegetation metrics and soil/carbon/wildlife characteristics of interest at co-located plots will help clarify which aspects of vegetation indicate valued ecosystem components that are difficult to measure across large spatial scales. If vegetation site photo analysis proves useful across the camera trap network the analysis could be extended (given additional resources) to a much larger network of acoustic recording unit deployment sites across the country where these vegetation site photos have been taken.

Working together on carbon and biodiversity

The Hudson Bay Lowlands serve as both a critical belowground carbon store and wildlife habitat, and characterizing spatial variation in carbon and wildlife habitat is important for informing land use decisions in the region. Across the 320,000 km2 area approximately 500 measures of peat depth (distance from the organic soil surface to its base) and 70 detailed analyses of organic soil carbon density with depth have been completed and are publicly available in scientific literature as a comprehensive dataset — these are used to inform our current estimates of carbon stocks across the Hudson Bay Lowlands. Yet, many of the historical measurements were opportunistic; without a systematic stratified sampling design key ecosystem types that comprise the natural heterogeneity of the region are omitted or poorly represented. In the summer of 2024, partners at the University of Guelph (supported by WLSD GCXE24S072 & NSRC) led one of the largest, coordinated organic soil carbon sampling programs to occur in the Hudson Bay Lowlands to address this knowledge gap. The first two years of the program generated an additional 42 detailed organic soil carbon density profiles (a 60% increase in the number of sampled points across the region) spanning six common ecosystem types found within the region. Samples were paired with peat depth measures to capture within site heterogeneity, generating an additional 210 data points (42% increase in the number of sampled points across the region). Locations for soil and detailed vegetation sampling were selected from the larger camera/ARU plot network established by CWS-ON to allow for analysis of associations with vegetation and wildlife. The outputs from this sampling effort will help further refine our estimates of carbon stocks across the region and improve understanding of mechanistic relationships that govern carbon accumulation patterns in the Hudson Bay Lowlands.

Partners at Wilfrid Laurier University (supported by WLSD GCXE22S048, GCXE24S071 & NSRC) developed an open-source workflow for camera trap image identification and identified animals in images from camera traps deployed by CWS-ON. To date, 3,756,927 images have been processed from 272 deployed cameras. They used the AI model MegaDetector (Hernandez et al., 2024) to identify 541,285 potential animal (or person/car) detections. Human analysts have fully processed and verified 195,753 of the images with potential detections and have identified animals in 37,770 of them. 91% of MegaDetector's potential detections were false positives, highlighting a need for an image analysis tool that more effectively distinguishes animals from leaves and debris in northern camera trap images. The Wilfrid Laurier team has explored several options for developing a machine learning image detector and classifier for the northern wildlife in this unique data set, but automatically distinguishing animals from leaves and debris remains challenging. The Wilfrid Laurier team is using the data to quantify spatial variation in wildlife diversity and co-occurrence, and CWS-ON is focussing on analysis of images of caribou and their predators.

Future possibilities

To help meet goals related to nature based climate solutions, cumulative effects, impact assessment, and monitoring of migratory birds and species at risk, WLSD, CWS-ON and others have made substantial investments in collection of baseline carbon and biodiversity data in the Hudson Plains and adjacent boreal shield ecozones. Both CWS-ON and research partners from the University of Guelph and Wilfrid Laurier University (supported in part by WLSD GCXE24S072 & GCXE24S071) have also made efforts to support the development of Indigenous environmental monitoring capacity in the region, and of research partnerships that are grounded in solid relationships of trust and foundation-building. Many of the benefits of these large investments could be lost or eroded if not transitioned to a foundation of sustainable long-term monitoring, capacity building, and relationship building. Matawa Four Rivers Environmental Services is uniquely positioned to work with Matawa communities, Guardians and Western-oriented scientists to establish such a foundation. Going forward, we would like to support Four Rivers (NSERC Alliance Society proposal in development) in the development of a long-term monitoring plot network to address community needs and priorities, grow and sustain research partnerships, and develop community capacity for carbon and biodiversity monitoring and decision making. If funded, this initiative will support the successful integration of relevant data and knowledge into informed decision-making processes and platforms in the region with a holistic approach led by First Nations, combining Indigenous and Western knowledge systems through a common stewardship goal. Informed decision-making by communities and all partners will be key to protecting and maintaining northern peatlands, and to the success of future development proposals within the Matawa member First Nation homelands.

Related Grants

GCXE25S033 (2024-2027) Alberta Biodiversity Monitoring Institute – Elly Knight. Leveraging bird model products and expertise to support decisions in the Hudson Bay Lowlands and other sparsely sampled regions

NSERC Alliance (2023-2028) Wilfrid Laurier University and University of Guelph – Frances Stewart, Catherine Dieleman, Jennifer Baltzer. Quantifying carbon-wildlife ecosystem service bundles across Ontario's Far North. Details - NSERC's Awards Database - Natural Sciences and Engineering Research Council of Canada

GCXE24S071 (2023-2028) Wilfrid Laurier University – Frances Stewart. Quantifying Carbon-Wildlife Ecosystem Service Bundles Where The James Bay Lowlands Meet The Boreal Shield: Terrestrial Wildlife

GCXE24S072 (2023-2028) University of Guelph – Catherine Dieleman. Quantifying Carbon-Wildlife Ecosystem Service Bundles Where The James Bay Lowlands Meet The Boreal Shield: Carbon and Vegetation

GCXE23S015 (2022-2023) University of Guelph - Catherine Dieleman. Characterization of ecohydrological-carbon relationships and surface-carbon ecosystem service bundles in northern peatlands in the Central Hudson Bay region.

GCXE22S048 (2021-2023) Wilfrid Laurier University – Jennifer Baltzer. Assessing and projecting cumulative effects of anthropogenic and natural disturbance on vegetation and wildlife in the Ring of Fire area.

GCXE21S046 (2020-2021) Wilfrid Laurier University - Jennifer Baltzer. Projecting cumulative effects of natural and anthropogenic disturbance on caribou in the Ring of Fire in Ontario.

GCXE21S047 (2020-2021) University of Alberta - Erin Bayne. Regionalization of BAM species distribution models for northern Ontario birds to improve cumulative effects modelling in the Ring of Fire Regional Assessment.

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Bats in Far North Ontario

Prioritising and Addressing Knowledge Gaps

Prepared By:

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Version: 1.0

Date:

2022/03/11

toronto zoo

NATIVE BAT CONSERVATION PROGRAM

NOTE:

This report is provided for background information and does not reflect recommendations by ECCC CWS-ON as they relate to the Regional Assessment in the Ring of Fire Area.

The following report was produced by a contractor for Environment and Climate Change Canada, Canadian Wildlife Service – Ontario Region (ECCC CWS-ON) in 2022. The recommendations provided in this report are those of the report author and are regarding the entire Far North of Ontario.

Note that at the time of this report, acoustic monitoring data collected by CWS has not yet been analyzed and eastern red bat, Hoary bat, and silver-haired bat COSEWIC assessments had not yet been completed.

Executive Summary:

Bats in Far North Ontario face increasing pressure from threats including disease, climate change, human development, and resource extraction. Data on bat populations and a robust understanding of their ecology is required to support effective decision making and the pursuit of goals set by the federal and provincial recovery strategy for relevant endangered species.

Up to six bat species have been recorded within Far North Ontario. There is strong evidence for the presence of five species: two federally and provincially endangered species, little brown myotis (*Myotis lucifugus*) and northern myotis (*M. septentrionalis*); and three species scheduled for assessment by the Committee on the Status of Endangered Wildlife in Canada in spring 2022, eastern red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), and silver-haired bat (*Lasionycteris noctivagans*). There is also tentative evidence for the presence of big brown bat. One study proposed that endangered tri-colored bat is present within the region, however, the evidence is tenuous, and this species was discounted for the purpose of this report.

The primary dataset for bats in Far North Ontario is an acoustic monitoring dataset collected by Ontario's provincial government during 2010–2014 as part of the Far North Biodiversity Project. Like other acoustic monitoring studies, these data are limited by the difficulty of distinguishing similar species (e.g., big brown and silver-haired bats) and detecting low amplitude, high frequency species (e.g., northern myotis). The Far North Biodiversity Project data provide a preliminary understanding of the distribution of bat species in the region. In summary, bat diversity and activity were higher in the Ontario Shield ecozone than the Hudson Bay Lowlands and higher in the southern ecoregions of the latter than those further north. Additional acoustic monitoring studies have been conducted since the Far North Biodiversity Project concluded, albeit at a smaller scale, and add limited species distribution data. Historic records of bat encounters confirm the past existence of little brown myotis in the southwest of the region and little brown myotis and northern myotis in the southeast.

The limited data available on bats in Far North Ontario means there are many problematic gaps in our understanding of their populations and ecology. This report identifies a total of 14 knowledge gaps, which can be broadly categorised as: gaps in baseline understanding of existing populations; gaps in understanding of species' habitat requirements; and gaps in understanding of anticipated threats to bats in the region. Specific knowledge gaps within these categories can be prioritised according to their relevance to decision making and species conservation. High priority baseline knowledge gaps include sub-regional population demographics and trends, hibernacula locations, and distributions and maternity roost locations for some species. High priority habitat requirement knowledge gaps are landscape scale maternity habitat, landscape scale hibernation habitat, and local scale maternity habitat for some species. The spread and impact of white-nose syndrome disease is a high priority threats knowledge gap, along with resiliency to habitat degradation and impacts of climate change, which were ranked medium and low respectively.

Bats are difficult species to study, and comprehensively addressing the full range of knowledge gaps will require a holistic combination of approaches. This report reviews 17 potential approaches and ranks them in order of anticipated value (knowledge gaps addressed), and practicality of implementation. High-value, easy-implementation activities include long-term acoustic studies (at local or regional scales) to address population demographics and trends and response to threats; local trap+release studies to address population demographics and landscape scale maternity habitat; and a desktop search for potential hibernacula to address species distributions, hibernacula locations, and landscape scale hibernation habitat. Activities with lower ranked value, but easy implementation include local or regional short-term acoustic studies, improved acoustic data reporting by proponents, reprocessing Far Northern Biodiversity Project data, and promoting Neighbourhood Bat Watch. Nine further approaches of varying value were determined to be difficult or impossible to implement currently but should be considered in future.

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Acknowledgements

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1 Background

1.1 Motivation

Bats are a significant component of mammalian diversity, accounting for approximately ten percent of mammal species in Ontario and Canada (Van Zyll de Jong, 1985). North American bat species typically have large ranges, covering many states and provinces (Reid, 2006), though abundance within their ranges varies considerably by species (e.g. Dobbyn et al., 1994). Despite these factors, bats are historically poorly monitored and many important aspects of their ecologies are not understood, a situation that has only recently begun to change

The situation in North America has begun to improve recently due to a combination of two interrelated factors: population decline and new monitoring technologies. White-nose syndrome (WNS), a disease caused by a non-native fugus first detected in North America in 2006, has caused rapid declines in several species. Population losses exceeding ninety percent in some cases triggered species protection legislation across various jurisdictions and led to urgent protection measures, in turn leading to increased species recovery actions. Alongside these population changes, the past fifteen years have also seen rapid innovation in acoustic monitoring techniques for bats combined with large declines in equipment prices. The increased utility and decreased cost of acoustic monitoring has changed the landscape of bat monitoring and decreased the cost of entry, allowing many new individuals and organisations to begin collecting non-invasive data.

While these recent factors have increased understanding of the ecology and populations of North American bat species, the new data and approaches also highlight the deficiencies and gaps in our knowledge. It is paramount to convert the surge of interest and capacity for bat monitoring and conservations from the past decade into sustainable and efficient models that protect these species in the long-term. This pressure is particularly acute in the boreal forests of the north, where bats remain largely unexplored, yet face unprecedented changes in the years to come.

1.2 Changing Boreal Landscape

The boreal forests of North America face change due to shifting climate and increasing human activity. Anticipated climate changes are expected to alter conditions in boreal regions; effects may include increased suitability for species whose northern range is bounded by climate limitations, along with larger functional shifts in the ecosystem (Price et al., 2013). Meanwhile, a push for increased resource extraction through mining and forestry (e.g. Ministry of Natural Resources and Forestry, 2013) is driving an increase in human activity and development. Such changes impact all bat species through habitat loss, fragmentation, and degradation. Collectively, these changes will likely change the wild populations inhabiting the boreal region, and alter their ecology, risk of extirpation, and management needs.

1.3 Target Region

Defined by the Far North Ontario Act (2010), the Far North Ontario region covers the northern extent of the province, spanning from the borders with Manitoba in the west and Quebec in the east (Figure 1). The region comprises 42% of Ontario's land area, while containing less than 0.2% of the province's human population (Ministry of Natural Resources and Forestry, 2013; Statistics Canada, 2021). Far North Ontario is home to many at risk species and migratory birds (Ministry of Natural Resources and Forestry, 2013). Commercial forestry potential has been identified in 6–7% of the region and while few mines currently operate in Far North Ontario, considerable potential for resource extraction has been identified (Ontario Ministry of Natural Resources, 2015).

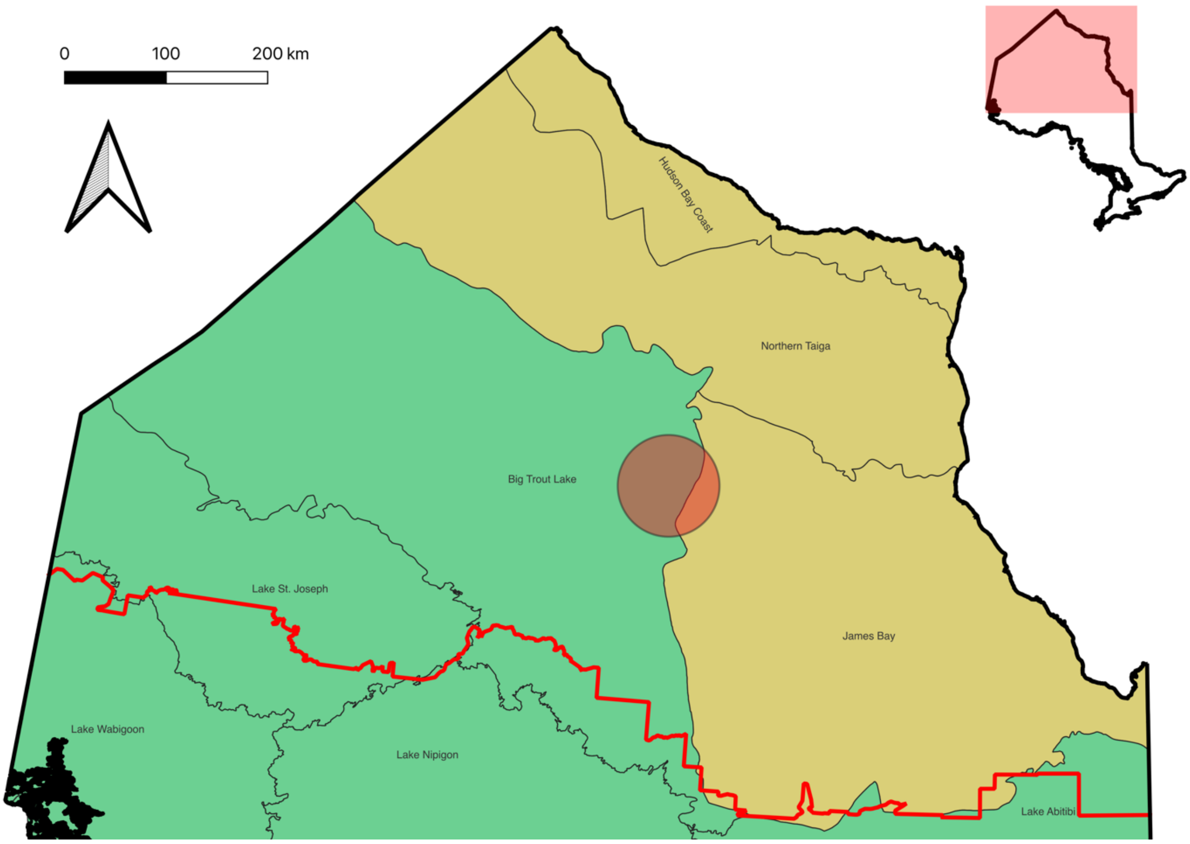

Figure 1: Ontario Shield (green) and Hudson Bay Lowland ecozones with their respective ecoregions, within the Far North Ontario (red boundary), the Ring of Fire mining crescent (red circle), and provincial boundary for Ontario (black line).

1.3.1 Ecozones

Far North Ontario contains two primary ecozones: the north-western extent of the Ontario Shield, and almost the entire Hudson Bay Lowlands, each containing several constituent ecoregions (Figure 1). The following descriptions are adapted from "The ecosystems of Ontario, Part 1: ecozones and ecoregions" (Crins et al., 2009).

The whole Ontario Shield ecozone covers more than 50% of Ontario. Two ecoregions, within the larger ecozone, form the majority of the Ontario Shield within Far North Ontario: Big Trout Lake and Lake St. Joseph. Both ecoregions have relatively dry and cold climates. Landcover in the Far North Ontario Shield is a combination of forest; coniferous, sparse, and mixed, and water and wetland features; open water, and treed bogs. Tree species include jack pine, black spruce, white spruce, balsam fir, trembling aspen, white birch, tamarack, balsam poplar, and black ash. Trapping, hunting, and fishing are the major land uses in both ecoregions, with increasing mineral exploration in the north and forest management in the south.

The Hudson Bay Lowlands ecozone encompasses three ecoregions: Hudson Bay Coast, Northern Taiga, and James Bay. Hudson Bay Lowlands accounts for approximately 25% of Ontario's area. It has a cold and semi-arid climate with long, cold winters and short, cool summers. Hudson Bay Lowlands are covered by a mixture of water, wetlands, and treed cover. The northern coastal extent, Hudson Bay Coast ecoregion, has the most open landscape, while the southwest extent, James Bay ecoregion, has the most treed habitat. Areas that do have tree cover are very different in nature to forest cover to the south: trees are often sparse and stunted stands of species including black spruce and tamarack. In southern extents, developed stands of coniferous and mixedwood boreal forest can exist in protected areas such as valleys, and along streams and rivers.

1.3.2 Ring of Fire Mining Crescent

Ontario's Ring of Fire mining crescent, 400 km northeast of Thunder Bay, is an area of land close to the centre of Far North Ontario. The Ring of Fire mining crescent is of high interest for resource extraction due to significant deposits of nickel, chromite, and other minerals. Numerous mining claims have been staked, and the Ontario government is keen to support development (Ontario Ministry of Natural Resources, 2015).

1.4 Target Species

Eight species of bat are resident in Ontario. This report focuses on six of these, including three federal species at risk, and three whose status is currently under review by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). These species are summarised in Table 1 below. One of the remaining two species, eastern small-footed myotis (*Myotis leibii*), has not been observed within or near to Far North Ontario. The other remaining species, big brown bat (*Eptesicus fuscus*) is suspected to occur in the Far North Ontario region (Layng et al., 2019), but is not currently considered to be at high conservation risk; this species is addressed in the report where relevant.

Table 1: Summary of target Ontario bat species addressed in this report.

Common Name	Scientific Name	Weight (g)	Roosting Preference	Overwintering Preference	Uses Anthropogenic Structures	SARA Status
Little Brown Myotis	*Myotis lucifugus*	5-14	Colonial; cavities in trees and buildings	Cave hibernator	Frequently	Endangered, Schedule 1
Northern Myotis	*Myotis septentrionalis*	5–8	Colonial; cavities in trees	Cave hibernator	Rarely	Endangered, Schedule 1
Tri-colored Bat	*Perimyotis subflavus*	4–8	Colonial; cavities and leaf clusters	Cave hibernator / suspected migrant*	Rare to never	Endangered, Schedule 1
Eastern Red Bat	*Lasiurus borealis*	7–18	Solitary; tree branches and bark	Migrates south	Rare to never	None
Hoary Bat	*Lasiurus cinereus*	18–35	Solitary; tree branches and bark	Migrates south	Rare to never	None
Silver-haired Bat	*Lasionycteris noctivagans*	8–12	Small colonies; tree bark and hollows	Migrates south	Rare to never	None

Due to ecological similarities, eastern red, hoary, and silver-haired bats may be referred to collectively as "migrant" or "migratory" bats throughout this report, where appropriate. Similarly, the *Myotis* species and tri-colored bat may be referred to as "hibernating" species when appropriate.

1.5 Legislation

Three target species: little brown myotis, northern myotis, and tri-colored bat, are currently listed as endangered under Schedule 1 of Canada's Species at Risk Act (SARA). These species were initially assessed as endangered in 2012 in an emergency assessment by the

Committee of the Status of Endangered Wildlife in Canada (COSWEIC). This determination was confirmed by a full assessment by COSEWIC in 2013 (Committee on the Status of Endangered Wildlife in Canada, 2013). The species were added to Schedule 1 of SARA in 2014.

Provincial analyses by the Committee for the Status of Species at Risk in Ontario also recommended endangered status for all three species (Committee on the Status of Species at Risk in Ontario, 2012a, 2012b, 2015). Little brown myotis, northern myotis and tri-colored bat were listed under Ontario's Endangered Species Act in 2013, 2013 and 2016 respectively.

Following the species' addition to SARA's Schedule 1, a federal recovery strategy was produced (Environment and Climate Change Canada, 2018). This recovery strategy was subsequently adopted, with an addendum, by the province of Ontario (Humphrey, 2019). The federal document outlines in detail the objectives and timelines to species recovery. Key recovery activities include expanding and standardising monitoring efforts, identifying population trends, investigating techniques to prevent or reduce the spread of or mitigate the effects of white-nose syndrome, engaging stakeholders, and understanding and tackling other threats. Short- and long-term activities specific to identifying Critical Habitat outlined in the recovery strategy are summarised below:

Short-term:

- Access and make existing data more broadly available
- Conduct surveys to determine the extent of the species' ranges where it is currently unknown (such as in the north)
- Confirm suspected Critical Habitat (maternity colonies and hibernacula)
- Refine and determine attributes for hibernacula, swarming, and maternity sites

Long-term:

- Increase surveys and monitoring at strategic locations
- At the landscape scale, determine the configuration of biophysical attributes required by the species and how they should be configured, then determine habitat quality across the range, with the goal of identifying additional critical habitat
- Identify anthropogenic effects on bat habitat
- Assess how much habitat is needed to meet population objectives
- Model summer habitat to determine where sufficient habitat is available to support objectives.

1.6 Report Intentions

The intentions of this report are threefold:

1) To collate and evaluate the currently available data for bats in Far North Ontario
2) To identify knowledge gaps in the ecology and status of bats in Far North Ontario
3) To prioritise and offer strategies to address these knowledge gaps

2 General Boreal Bat Ecology

The following section provides a brief primer on the basic ecology and issues faced by boreal bat populations. It is principally drawn from primary literature focused on the boreal forest of North America. This is not intended to provide a comprehensive review of all issues, but rather to establish a sufficient baseline of knowledge of key issues to support the reader in understanding and interpreting the concepts presented in the following sections.

2.1 Distribution

Understanding where a species occurs is a fundamental step to effective management actions. However, bat species are highly mobile with large home ranges, are often migratory or seasonal, and are difficult to observe. Many bat species have large global ranges, and their ecology varies considerably throughout.

2.1.1 Climate Limitations

The northern ranges of boreal bats are determined by the availability of suitable roosting and foraging habitat (Lippert, 2001). These factors are in turn determined by the climatic and associated land cover characteristics. In a study of climatic limitations on the range of hibernating little brown myotis, Humphries et al (2002) defined the northern boundary for little brown myotis hibernation as occurring somewhere within Northern Ontario, with almost the entire Far North Ontario region falling within the bounds of probability. These ranges are expected to change in accordance with climate shifts.

2.1.2 Data Limitations

Studies of bats in North America's boreal forests are sparse and limited, compared to southern extents of the species' ranges. As a result, the northern extent of the ranges of many species are extrapolated from few records, with large margins for inaccuracy (Mills et al., 2013). In most jurisdictions data are comprised of scattered, and often historic, incidental observations combined with a handful of deliberate acoustic or capture based surveys. See section 3 for a review of available data in Ontario's boreal forest.

2.1.3 Sex Biased Distribution

The potential for variation in distribution between males and females is an important consideration for bat distributions. During the summer season reproductive female bats have high energetic demands. They may also be limited by specific roosting habitat requirements, especially for species that form large colonies. These effects can lead to a 'sex biased distribution', where males and females occupy different areas (Broders et al., 2006). These distributions are expected to involve reproductive females occupying optimum habitat, while males and non-reproductive females survive in sub-optimal habitat.

2.2 Habitat

2.2.1 Myotis Species

Little brown myotis are a cavity roosting species that forms maternity colonies of up to several hundred individuals. Natural maternity roosts typically occur in hollow trees (Parsons et al., 2003) and populations exhibit "fission–fusion" dynamics, with frequent swapping of individuals between small roosting groups within a larger population (Olson, 2011). Little brown myotis have been observed to switch maternity roosts regularly (Psyllakis & Brigham, 2006). In the Yukon, little brown myotis have been observed roosting in rock cavities (Slough, 2009). Male little brown myotis frequently roost under loose bark, and show a preference for areas with canopy gaps and increased numbers of snags (Fabianek et al., 2014).

Maternity roosts of little brown myotis are frequently encountered in anthropogenic structures, where available, and populations can remain loyal to a structure over multiple seasons

(Dubois & Monson, 2007; Norquay et al., 2013). Roosting in buildings may be thermally advantageous for bats, and Thomas and Jung (2019) explored the hypothesis that human structures in the Yukon have supported expansions of the range of little brown myotis: an association did occur, but further research suggested the availability of roosting structures was not a limiting factor (Thomas et al., 2021).

Northern myotis, unlike little brown myotis, rarely roost in anthropogenic structures (Caceres & Barclay, 2000), and maternity roosts are observed almost exclusively in trees (Thorne et al., 2021). Male northern myotis in a study by Jung et al (2004) in Central Ontario showed a preference for mid-decay trees in forest patches that were less dense than typical; individuals frequently switching between ephemeral roosts located on upper slopes and facing east to southeast. Studies in the Yukon found this species associated with white-spruce, balsam poplar, and occasionally tamarack and trembling aspen (Lausen et al., 2008).

Both little brown and northern myotis overwinter at hibernacula, but few studies describe this behaviour in boreal forest. Studies at hibernacula in Manitoba and north-western Ontario indicate high site fidelity, with occasional switching by females (Dubois & Monson, 2007; Norquay et al., 2013). Sites with high fidelity in these studies were assumed to be high quality, but this evaluation was not explored in the publications.

Foraging activity of *Myotis* bats in boreal forest has been associated with open water and riparian habitat in the Yukon and Labrador (Burns et al., 2015; Slough & Jung, 2008; Thomas et al., 2021; Thomas & Jung, 2019). *Myotis* in the Yukon studied by Slough and Jung (2020) also showed roost switching within, but not beyond, an inferred foraging area at a greater frequency than reported for southern populations. Slough and Jung report that long distance relocations between foraging areas (> 25 km) were rare, occurring in less than 1% of bats. They posit that high fidelity to foraging areas even while moving between roosts could make identification of summer foraging areas a more effective approach to identify summer habitat than relying on roosts alone.

2.2.2 Migratory Bats

Very few data exist for migratory bats in boreal regions. No published studies describe the roosting and migratory behaviour of these species in the far north of their ranges, although these requirements are moderately understood for southern populations. Foraging eastern red bats, hoary bats, and silver-haired bats were observed to associate with mixed forest stands in northern Alberta (Lausen, 2014). Open habitat and forest clear cuts were associated with eastern red bat and hoary bats in central Ontario (Jung et al., 1999; Mills et al., 2013).

2.2.3 Summary

The importance of old growth forest to summer habitat of most bat species was a consistent theme across many studies and regions, while heterogeneity of tree species, age class, and density within forest patches increased attractiveness (Jung et al., 1999; Kalcounis et al., 1999). However, such relationships are often very difficult to define at a small scale (Lippert, 2001). In Far North Ontario, this type of forested habitat is primarily associated with the Ontario Shield ecozone, which has a variety of forest types across its range. The availability of features such as mature trees in the Hudson Bay Lowlands is much sparser, and this may limit the suitability of this region for many bat species.

2.3 Threats

2.3.1 White-Nose Syndrome

White-nose syndrome is a disease that affects cave hibernating bats, caused by the fungus *Pseudogymnoascus destructans* (*Pd*). Bats encounter the fungus while overwintering in caves; it grows on their bodies causing them to wake and expend energy they are unable to replace during winter, resulting in death by starvation (Frick et al., 2016). First detected in Ontario in 2010, WNS affects three target species for this report: little brown myotis, northern myotis, and tri-colored bat (Ministry of Natural Resources and Forestry, 2015). Presence of *Pd* can be confirmed through environmental swabbing of bats in hibernacula to test for presence of the fungus, ideally undertaken in late March while clinical confirmation of WNS requires examination of bat carcasses (Canadian Wildlife Health Cooperative, 2015).

Limited historic data complicates any assessment on the impact of WNS on bats in Ontario. However, changes in populations affected species in the province appear to be dramatic. Pre and post WNS counts of bats at eight hibernacula in Ontario recorded a 93% total decline by 2013 (Committee on the Status of Endangered Wildlife in Canada, 2013). WNS has been confirmed in 24 Ontario counties, and is suspected in 4 more (Canadian Wildlife Health Cooperative, 2021, Figure 2). None of these reported observations of *Pd* or WNS is in the Far North Ontario region, almost certainly due to the absence of known hibernacula and lack of surveillance. However, one confirmed WNS detection in southwest Kenora District falls within 50 km of the Far North Ontario region and was recorded in the winter of 2016–17.

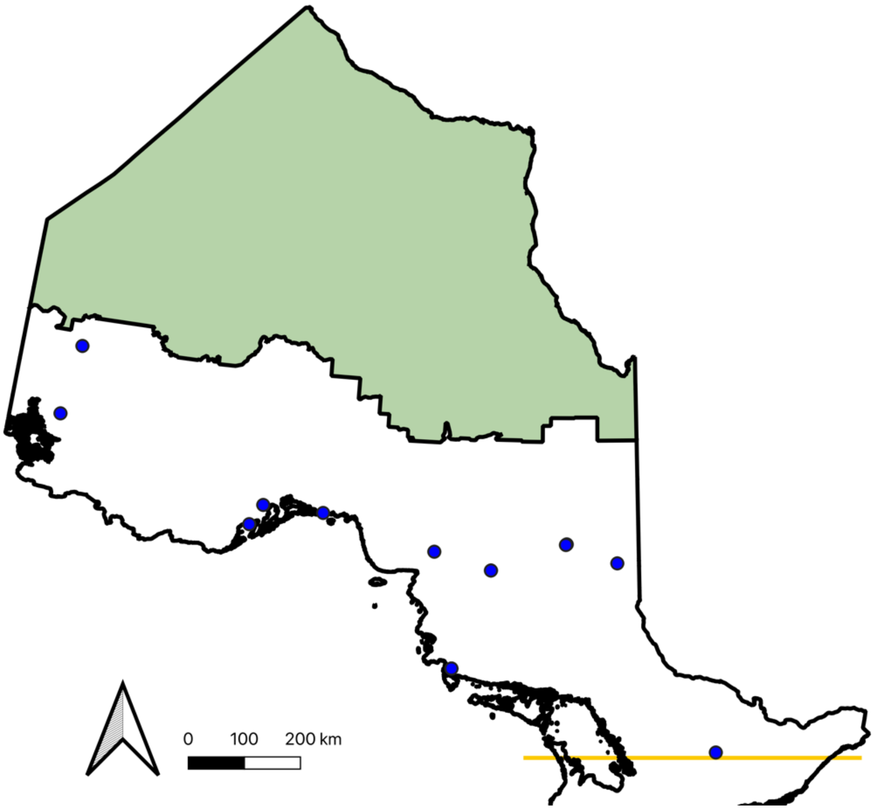

Figure 2: Locations of WNS detections (blue points) in Ontario (black boundary) north of 45° (yellow line), relative to the Far North Ontario region (shaded green). Data provided by the Canadian Wildlife Health Cooperative.

To date bats in northern and western boreal forests of North America have been less impacted by WNS because the fungus has not yet reached these locations (Frick et al., 2016; Thomas et al., 2021). However, the absence of *Pd* or WNS records to date in Far North Ontario cannot be taken as an indication that the disease is absent from the region. WNS records in Ontario come from sporadic and opportunistic observations, and to date there has been no strategic monitoring effort. The detection of WNS in southwest Kenora District five years ago suggests there is a high likelihood that WNS now occurs in Far North Ontario.

2.3.2 Climate Change

Ontario represents the northern range extend for many species, including all eight bat species in the province. The northern ranges of bats are limited in part by climate (see section 2.1.1). Although relatively little attention has been paid to the potential impact of climate change on bats in North America, modelling studies such as work by Humphries et al (2002) can predict potential ranges of species or suitable habitat, and thence climate change predictions can be used to examine how distributions might change. Northern expansions in the range of eastern red bat are suspected in western boreal forests, but limited historic and contemporary data make these hypotheses difficult to prove (Lausen, 2014). While range expansions due to climate change may be seen as advantageous, climatic changes are also likely to bring negative impacts. Jung (2019) discussed the potential harm of increasing forest fires in the boreal region as climates warm, but few other risks have been studied in detail.

2.3.3 Habitat Loss / Anthropogenic Development

Commercial forestry causes significant change to the landscape through clear-cutting and increased homogeneity (Lippert, 2001). Several studies have examined the impacts of forestry on bat activity: Hogberg et al (2002) observed higher bat activity in clear-cut areas that retained residual patches intended to mimic natural areas skipped by fire; Patriquin and Barclay (2003) recorded similar activity by little brown myotis across various treatments of thinning and clearing, while silver-haired bats were more common in open sites; and Thomas et al (2019) found no variation in *Myotis* activity between different treatments of salvage logged versus non-logged sites. The variation among these studies suggest that further investigation is required to fully understand the impacts of commercial forestry on boreal bats.

Urban development in the boreal forest of North America is sparse and low density, and there are few data on the impact of urban developments on bats. A study in the Yukon initially found that human development measures were a poor predictor of bat activity (Thomas & Jung, 2019), however, subsequent investigations found lower activity of little brown myotis in areas with a larger human footprint (Thomas et al., 2021).

Few data are available on the impact of wind power developments in boreal forest, and any such development would require extensive study. Significant concerns exist over the impact of these developments on bats further south in their ranges (e.g. Friedenberg & Frick, 2021). Long-term acoustic monitoring in Quebec, south of the boreal region, identified declines in activity of migratory bats following wind power developments (Faure-Lacroix et al., 2020).

Other anthropogenic developments such as operation and closures of mines, and road development are likely to impact bats, but have not been investigated in a boreal context. Road developments can significantly disrupt the distributions of bat populations (Kerth & Melber, 2009), however, low traffic roads without lighting could be beneficial as linear features similar to other features used by boreal bats (Lausen, 2014).

3 Existing Data

3.1 Far North Ontario

3.1.1 Overview

Compared to many other regions, data on bats in Far North Ontario is sparse and limited. Except for six historic (1929–1981) specimens recorded by Ontario's Natural Heritage Information Centre, all available data are drawn from acoustic monitoring data. Extant data are widely distributed across the region (Figure 3), although the majority of this geographic spread results from a single dataset.

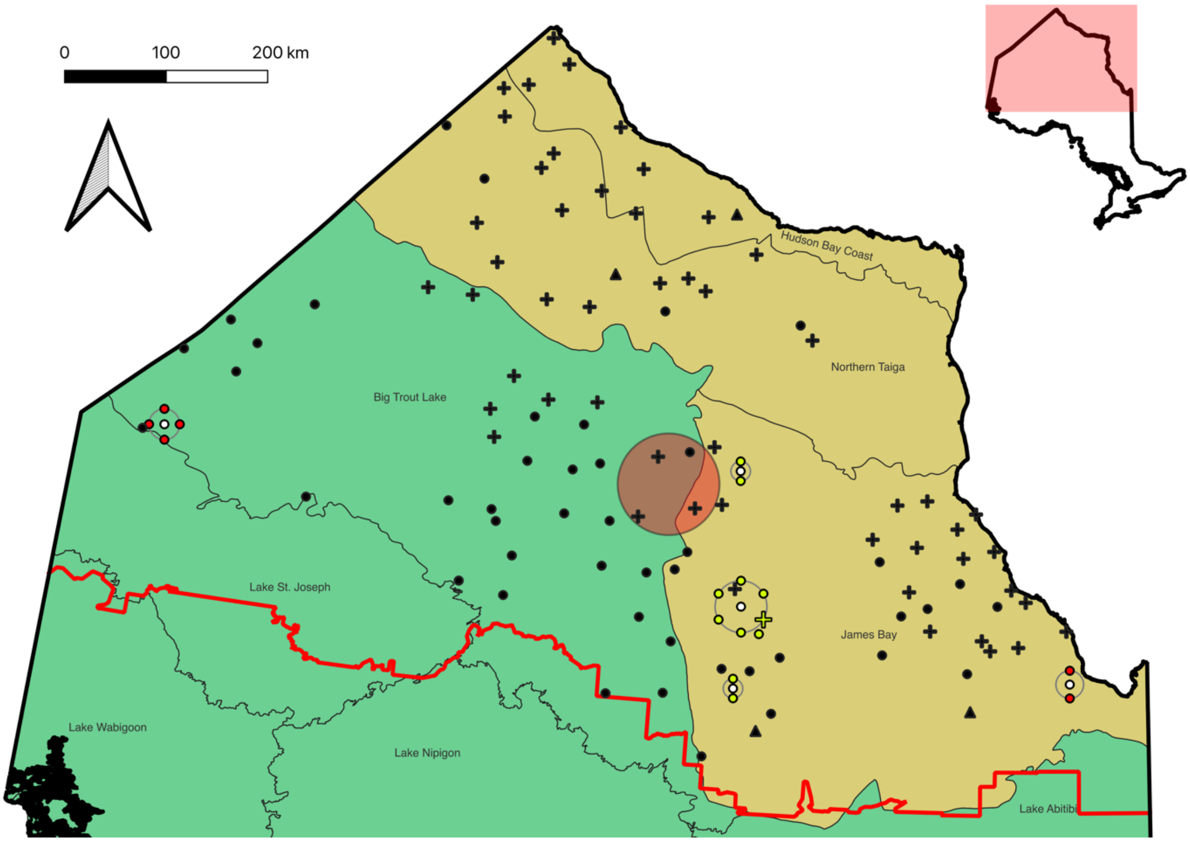

Figure 3: All available datapoints and datasets for bats in Far North Ontario. Black symbols represent locations with acoustic monitoring data from the Far North Biodiversity Project (2010–2014) as reported by Layng et al (2019); red symbols represent locations of bat observations recorded by Ontario's Natural Heritage Information Centre; yellow symbols represent locations with acoustic monitoring data collected by Canadian Wildlife Service (2021). Circles indicate bats were observed, triangles indicate uncertain acoustic detections of bats, and crosses indicate search effort, but no bats observed. Overlapping point locations are indicated by white circles with the relevant points arranged on the surrounding ring. Base colours represent ecozone: yellow, Hudson Bay Lowlands; green, Ontario Shield. Thick black lines indicate Ontario's provincial border; thin black lines define individual ecoregions; and the southern boundary of the Far North Ontario region is depicted by a thick red line. The approximate location of the Ring of Fire mining crescent is represented by a red overlay. Only bat observations within the Far North Ontario region are shown.

These data suggest the presence of up to six species of bat, including five target species of this report: little brown myotis, northern myotis, eastern-red bat, hoary bat, and silver-haired bat. Big brown bats were also observed. A seventh species, tri-colored bat (the final target species of this report), was also suggested to be present by one dataset (Layng et al., 2019). However, is limited data to support this claim, and it was discounted from further consideration for reasons discussed in section 3.1.3.2.

Little brown and northern myotis were both observed across the southern extent of Far North Ontario, including the Ontario Shield ecozone, and the James Bay ecoregion of the Hudson Bay Lowlands ecozone. Northern myotis, a species that roosts primarily in trees (Caceres & Barclay, 2000) was reported in recent acoustic observations within the Ontario Shield ecozone (Layng et al., 2019). However, this species was not observed in Hudson Bay Lowlands in the same study, or in 2021 acoustic monitoring undertaken by Canadian Wildlife Service (Myotistar, 2021), despite historic record of a female collected in Moose Factory in 1981. Little brown myotis, a more ecologically flexible species (Fenton & Barclay, 1980), was detected acoustically throughout the Far North Ontario region, except for the extreme north, with no observations in the Hudson Bay Coast ecoregion (Layng et al., 2019; Myotistar, 2021). The historic presence of little brown myotis in both the Ontario Shield and Hudson Bay Lowlands ecozones is further supported by historic specimens collected in 1938 and 1928 respectively. These species typically overwinter by hibernation in underground sites (Caceres & Barclay, 2000; Fenton & Barclay, 1980).

Eastern red bat and hoary bat are reported from acoustic observations across the Ontario Shield ecozone and James Bay ecoregion in Far North Ontario, with hoary bat also observed further north in the Northern Taiga ecoregion (Layng et al., 2019). The latter observations are the most northerly available records for bats in Ontario. Recent acoustic monitoring in the James Bay ecoregion corroborated the presence of hoary bat, but did not collect confident observations of eastern red bat (Myotistar, 2021). These are solitary species that roost on the bark and among the branches of trees. Eastern red and hoary bats are also long-distance migrants that travel south to overwinter (Cryan, 2003).

Silver-haired bat, and the non-target species big brown bat are ecologically disparate, however, there is considerable overlap in their echolocation call repertoires that confounds acoustic surveys for this pair. Silver-haired bat is a long-distance migrant (Cryan, 2003) that forms small colonies in hollows and under loose bark on the trunks of trees (Bohn, 2017). Big brown bats are a cavity dwelling species that form large colonies and frequently, perhaps preferentially, occupy anthropogenic structures when available and overwinter through hibernation close to their summer ranges (Miller et al., 2016). Layng et al (2019) report sparse acoustic observations for these species in the Ontario Shield ecozone, and observations of big brown bat at a single site in the James Bay ecoregion of the Hudson Bay Lowlands ecozone. Conversely, 2021 data collection in the James Bay ecoregion identified silver-haired bat at several locations in the southern Hudson Bay Lowlands ecozone, but identified no big brown bats (Myotistar, 2021).

Collectively, these data build a strong case for the established presence of multiple bat species in the Far North Ontario region. However, several substantial limitations constrain the conclusions that can be drawn about regional populations and ecology of said species. Firstly, almost all the available data were collected through acoustic monitoring, and thus do not provide any demographic data about the bats that were observed. Secondly, all the available data comes from short-term studies or incidental observations, giving no insight into long-term population changes or distribution. Thirdly, with almost all available data collected acoustically in the summer months, there is limited insight into habitat associations for important behaviours such as maternity and hibernation or latitudinal migrations. Finally, although the existing data are widely distributed across the region, substantial areas remain unmonitored while most other areas were monitored briefly in a single season.

The lack of demographic and trend data for bats in Far North Ontario, along with distribution data that is arguably already out of date due to advancing WNS, contributes to considerable knowledge gaps. These knowledge gaps are addressed in greater depth in section 4. The remainder of this section reviews the available data sources for bats in Far North Ontario in greater depth.

3.1.2 Limitations of Acoustic Species Identification

Due to the reliance on acoustic data for our understanding of bats in Far North Ontario, it is important to understand the limitations of identifying species using this approach.

A fundamental challenge is the difficulty of distinguishing calls of species with overlapping echolocation repertoires. Most bats have large repertoires to match the requirements of their ecology, while species with similar ecologies often use similar calls, meaning that intra-species variation in echolocation can exceed inter-species variation in some cases. For example, there is considerable overlap between the echolocation calls of big brown bat and silver-haired bat, and a smaller overlap between these species and hoary bat and eastern red bat. Each species has a varied repertoire of calls, some of which are unique, while others overlap with other species to varying degrees. These overlaps are challenging when trying to affirm species presence from a low number of observations. For example: a collection of recordings in a location with both big brown bat and silver-haired bat might include approximately 20 percent each of calls that can be confidently identified as either species, leaving 60 percent to fall into an uncertain category, however, in this case there are sufficient observations of each species to be relatively confident in their presence. Conversely, if most of the calls appear the be a single species, such as eastern red bat, and a minority of calls appear to be a species that infrequently overlaps with eastern red bat such as big brown bat, the conservative assumption is that only eastern red bats are present, and the few observations of big brown bat can be dismissed.

Further to the issue of call overlap between species, acoustic monitoring is also limited by the difficulty of recording accurate observations of some species. A prominent example of this is northern myotis. This species is a low amplitude echolocator, which means it must be closer to the microphone than louder species to be recorded, effectively reducing the sampling volume of an acoustic monitor compared to that for louder bats. Further, it is a high frequency echolocator, which also makes it less detectable; higher amplitude sounds attenuate faster in air. A sound at 40 kHz is detectable at approximately half the distance of a 20 kHz sound due to the difference in attenuation (Adams et al., 2012). This issue applies to several low-amplitude, high-frequency echolocators such as *Myotis* species and tri-colored bat. However, the issue is greatest for northern myotis because a key feature of their echolocation calls, used to confirm identity, is a high start frequency exceeding 100 kHz. Due to attenuation, many recordings of northern myotis can be expected to omit this feature, making it challenging to confidently assign identification and leading to the observation being recorded as an unidentified *Myotis* species.

3.1.3 Far North Biodiversity Project Acoustic Monitoring Data / Layng et al 2019

The most comprehensive data on bats in Far North Ontario is an acoustic monitoring dataset collected by Ontario’s Ministry of Northern Development, Mines, Natural Resources and Forestry as part of the Far North Biodiversity Project. Neither raw nor summary data were available for review to support the production of this report. Considerable data organisation and verification would be required prior to sharing, which the ministry does not currently have the resources to undertake on a reasonable timescale (pers. com. Philip DeWitt, MNRF, 2021). However, a detailed description and analysis of the data is available through a peer-reviewed publication by Layng et al (2019). Subsequent discussion of these data in this report is drawn primarily from this publication.

3.1.3.1 Methods and Limitations

Data were collected between 2010 and 2014, with the intention of providing a foundational understanding of living terrestrial resources in the region to support land use planning. Data collection locations were selected based upon the land use planning factors relating to First Nation communities in the region. This produced a relatively widespread distribution of monitoring locations (see Layng et al., 2019, Figure 1). Specifically, data monitoring locations were densely clustered North of Moosonee and around Fort Albany in the east; centrally from

Nibinamik to the Ring of Fire mining crescent and south to Marten Falls; in the central north from Fort Severn to Peawanuch; and northwest of Keewaywin in the west. Little to no data were collected in the southwest, northeast, and far southeast of Far North Ontario. Data collection occurred under several monitoring regimes over the five-year monitoring period, described in detail by Layng et al (2019).

Data were collected using Song Meter SM2BAT (Wildlife Acoustics, U.S.A.) autonomous recording units (ARUs). While quite acceptable for the time, these units have some limitations compared to updated modern equipment. Most relevant, the units deployed had a maximum sampling frequent of 192 kHz. The maximum frequency a recorder can detect is no more than half the sampling frequency, meaning units were limited to a maximum recording frequency of 96 kHz. The is notable because it reduces the certainty of any distinction between little brown myotis and northern myotis. The start frequency of northern myotis often exceeds 96 kHz, and high start frequencies can be an important diagnostic point. A smaller proportion of data were collected using batcorder 2.0 ARUs (ecoObs, Germany), which do not have the same limitation.

Species identification of the bat observations obtained in this dataset was undertaken using two automated methods: a quadratic discriminant function analysis (DFA), written by the researchers using example bat recordings from Ontario, and Kaleidoscope, a commercial analysis software (Wildlife Acoustics, U.S.A.). There was considerable disagreement between the results of the two classifiers. For example, of the 1,342 observations identified as hoary bat by the DFA, only 294 were similarly identified by Kaleidoscope. The larger proportion of hoary bat observations identified by the DFA were identified as silver-haired bat by Kaleidoscope. Hoary bat and silver-haired bat typically echolocate in distinct, albeit adjacent, frequency ranges. Accordingly, the discrepancy for these, and other relatively distinct species, gives some cause for concern regarding the accuracy of species identifications. Manual review of the automated classifications would address these concerns, but limited manual review is described in the manuscript.

3.1.3.2 Observations

Layng et al (2019) identified seven species in their analyses of the data. These included all Ontario species except for eastern small-footed myotis. The authors note that their analyses were not suitable to distinguish the eastern small-footed myotis from little brown myotis, however, detections in Far North Ontario would be a considerable range extension for this species and questionable if based solely on acoustics. The six target species for this report were all reported, along with big brown bat.

Despire being reported in the Far North Biodiversity Project data, tri-colored bat is assumed to not occur in Far North Ontario for the purpose of this report, pending further data to refine the species' northern range. Five bat observations were identified as tri-colored bat by the automatic classifiers used by Layng et al (2019), one of which was confirmed as tri-colored bat through manual review. This represents an range extension of almost 1000 km beyond the established range for the species (Van Zyll de Jong, 1985). Given the limitations of acoustic data for identifying bat species (Fraser et al., 2021) and the considerable variation in species identifications that can occur even between expert manual identifications (Fraser, 2018), determining such a large range expansion based on a single recording is questionable. Ontario's Ministry of Northern Development, Mines, Natural Resources and Forestry is currently reviewing the identifications of these files (pers. com. Philip DeWitt, MNRF, 2021), but further information and the files themselves were not available for this report.

For the remaining six species, most monitoring sites with bat observations were in the Ontario Shield section of the Far North Ontario region (Table 2, Figure 3). Most Ontario Shield monitoring locations occurs in the Big Trout Lake ecoregion, and bats were observed at 74% of these, along with the single monitoring location in the Lake St. Joseph ecoregion. In contrast, bats were observed at a minority of sites in the Hudson Bay Lowlands ecozone in Far North Ontario. Within this ecozone bat activity was concentrated in the south, with bats identified at 39% of sites in the southerly James Bay ecoregion versus 0% and 19% of sites in the more northern Hudson Bay Coast and Northern Taiga ecoregions respectively (Table 2, Figure 3).

Table 2: Number of sites with confirmed observations, and percentage of all sites, for each target species and big brown bat in each of the five ecozones covered by the Far North Biodiversity bat monitoring dataset (Layng et al., 2019). Observations listed as 'uncertain' were omitted due to the limitations of acoustic species identification.

Species	Ecozone	Hudson Bay Lowlands			Ontario Shield	
	Ecoregion	Hudson Bay Coast	Northern Taiga	James Bay	Big Trout Lake	Lake St. Joseph
	Sites	7	21	36	35	1
All Bats	Total	0	4	14	26	1
	Percentage	0%	19%	39%	74%	100%
Little Brown Myotis	Total	0	1	7	21	1
	Percentage	0%	5%	19%	60%	100%
Northern Myotis	Total	0	0	0	8	1
	Percentage	0%	0%	0%	23%	100%
Eastern Red Bat	Total	0	0	6	8	1
	Percentage	0%	0%	17%	23%	100%
Hoary Bat	Total	0	3	11	17	0
	Percentage	0%	14%	31%	49%	0%
Silver-haired Bat	Total	0	0	0	2	0
	Percentage	0%	0%	0%	6%	0%
Big Brown Bat	*Total*	*0*	*0*	*1*	*2*	*0*
	Percentage	*0%*	*0%*	*3%*	*6%*	*0%*

The trend for lower activity in Hudson Bay Lowlands, compared to the Ontario Shield (specifically the Big Trout Lake ecoregion, with a single location in the Lake St. Joseph ecoregion), was consistent across all species. Two species, northern myotis and silver-haired bat, were present (albeit at a small proportion of locations) in the Ontario Shield, but weren't observed at all in the Hudson Bay Lowlands (Table 2). Two species: big brown bat and eastern red bat, were observed in the James Bay ecoregion but not in the two more northern ecoregions of the Hudson Bay Lowlands.

Notably, the two species observed at the highest latitudes, little brown myotis and hoary bat, are ecologically distinct. Little brown myotis are small, cavity dwelling bats that form large colonies, while hoary bats are Ontario's largest species and are a solitary species that roosts on the outer bark and branches of trees. These observations imply that the Hudson Bay Lowlands can support some level of bat diversity.

The remaining four species are most abundant in the Ontario shield ecozone, and the southwest extent of the Hudson Bay Lowlands (Layng et al., 2019; Figure 2). However, even within these regions, observations were sparse relative to those for hoary bat and little brown myotis. This distribution is supported by predictive occupancy modelling, which suggested that the Lake St. Joseph, Big Trout Lake, and southern James Bay ecoregions had the highest probability of occupancy for all species, which the exception of silver-haired bat which only had moderate occupancy probability (Layng et al., 2019; Figure 2).

Although not a target species for this report, big brown bat was recorded among the species identified in Far North Ontario by Layng et al (2019). These observations represent a modest range expansion for this species of a few hundred kilometres beyond the accepted distribution (Van Zyll de Jong, 1985). This is more feasible than the proposed range expansion of tri-colored bat, discussed above. However, it should be noted that there is considerable overlap between the echolocation calls of big brown bats and silver-haired bats, and these species are arguably indistinguishable for large proportions of their repertoires. Accordingly, this observation should be treated with caution.

3.1.4 Preliminary Ring of Fire Region Acoustic Monitoring

In 2021 Canadian Wildlife Service undertook acoustic data collection in Far North Ontario, with data analysis contracted to Myotistar. All data collection took place in the James Bay ecoregion within the Hudson Bay Lowlands ecozone. Monitoring sites were distributed at a range of latitudes in the western half of the ecoregion. Data were collected using Song Meter SM4BAT ARUs (Wildlife Acoustics, U.S.A.) programmed to record nightly for one week in June, and then intermittently subsequently. Data were analysed using autoclassification in SonoBat (SonoBat, U.S.A.) and manual verification. The use of updated equipment, and more extensive manual verification in this study addresses some of the limitations in the data presented by Layng et al (2019), discussed above (section 0).

Preliminary analysis indicates the probable presence of three species: little brown myotis, hoary bat, and silver-haired bat (Myotistar, 2021); eastern red bat was considered possible unconfirmed by the available data. Activity levels were variable and low across the dataset compared to expected activity from a similar monitoring effort in South Ontario. No strong patterns in the timing of activity were discernible in preliminary analysis, although early activity in one location may have suggested a nearby roost. However, in the absence of demographic data for the individuals recorded this observation is of limited value.

3.1.5 Ontario's Natural Heritage Information Centre Data

Ontario's Natural Heritage Information Centre (NHIC) collects data on a subset of Ontario's flora and fauna. Four bat species are provincially tracked: little brown myotis, northern myotis, eastern small-footed myotis, and tri-colored bat. NHIC currently holds three observations of tracked bats in Far North Ontario, all of which are historic. Four little brown myotis specimens were collected in the western extent of the Big Trout Lake ecoregion in 1938: three adult females and one adult make, with no data to suggest a colony or roost nearby. In 1929 a single little brown myotis was recorded in Moose Factory, in the southeast of the James Bay ecoregion, with no further biometrics recorded. Finally, in 1981 an adult female northern myotis was collected in Moose Factory, close to the previous record.

3.1.6 Four Rivers Environmental Services Group

The Four Rivers Environment Services Group of Matawa First Nations Management has been collecting acoustic observations of bats in Far North Ontario since 2017, in collaboration with First Nation communities. These data were not available for incorporation into this report: early data have been professionally processed, but permission from the local community for data sharing is not currently in place; processing of recent data is still underway.

3.1.7 Gord Parker

Mr. Gord Parker of Land Based Learning has collaborated with First Nation partners to collect data on bats in the Far North Ontario region, primarily along the Winisk River. Community consultation is required before these data could be shared. However, the data have been professionally analysed and do confirm the presence of bats in the monitoring area.

3.1.8 Marten Falls Community Access Road, Webequie Supply Road, and Northern Road Link projects

Pre-construction acoustic bat monitoring data collection is underway for three proposed road developments connecting the Ring of Fire mining crescent to Ontario's road network. These data were not available for the purpose of this report. However, proponents are interested in establishing a collective data sharing agreement with agencies such as Canadian Wildlife

Service to facilitate effective assessment of bats in the area (pers. com. Erin Greenaway, WSP, 2022).

3.2 Relevant Northern Ontario Data

3.2.1 Mills et al *2013*

Mills et al (2013) collected acoustic data within the Ontario Shield ecozone near to Timmins, approximately 200 km south of the Far North Ontario region. Data were collected in a mixture of clear-cuts, forest patch edges, and within intact forest. Six species were identified: little brown myotis, northern myotis, eastern red bat, hoary bat, silver-haired bat, and big brown bat. These observations were the first time big brown bat was recorded in the region. Bat activity was greatest at edge habitats.

3.2.2 Norquay et al *2013*

Norquay et al (2013) examined movements of little brown myotis between summer maternity roosts and winter hibernacula using banding records. The study focussed on sites in Manitoba and included two sites in the western extreme of the Ontario Shield ecozone, approximately 215 km south of the Far North Ontario region. Bats in the study were loyal to both hibernacula and maternity colonies, with 96% and 88% fidelity respectively. The maximum relocation distance between hibernacula reported by Norquay et al was 560 km, suggesting that these bats could also visit Far North Ontario if suitable sites exist there. Relocation by females occurred more than for males, implying that females face greater competition for high quality sites.

3.2.3 Ontario's Natural Heritage Information Centre

In addition to the NHIC observations in Far North Ontario discussed in section 3.2.3, the province also possesses more than 100 element occurrences for little brown myotis and northern myotis within the Ontario Shield ecozone outside of the far north region. The closest of these occurrences are less than 50 km from the southern boundary of Far North Ontario, but the majority are more than 150 km south.

3.2.4 Public Environmental Impact Data

Bat observations collected during environmental impact assessments are not always reported or shared beyond their immediate use. However, such observations can provide a valuable data source. A search of publicly available data did not produce any environmental assessment reports for Far North Ontario. However, publicly available reports for seven developments in Northern Ontario, south of the Far North Ontario boundary did mention bats. These observations are presented in Figure 4 below.

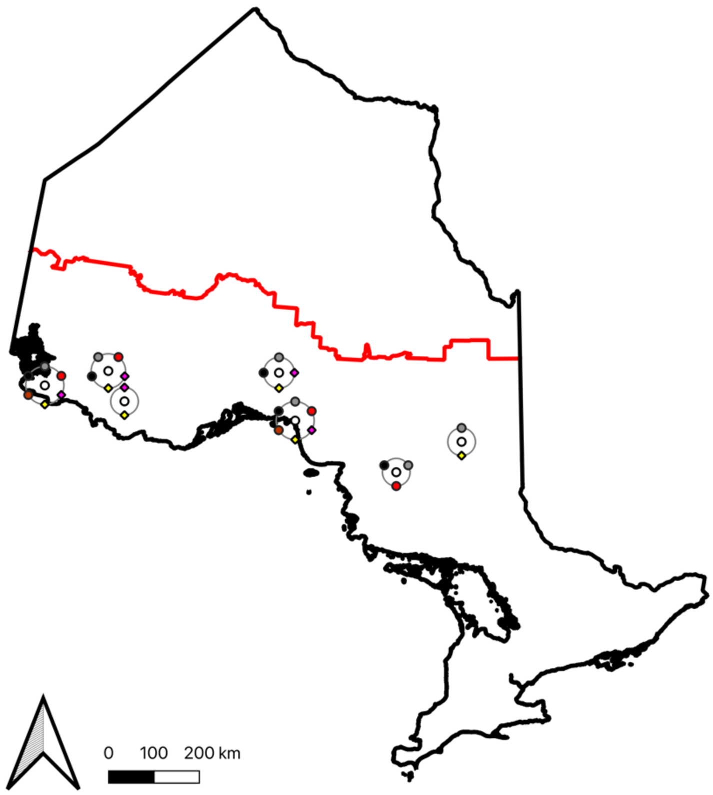

Figure 4: Reported observations derived from publicly available environmental impact assessment reports associated with developments in Northern Ontario. Observations are represented by white points at the approximate geographic location, surrounded by a ring of points indicating the species reported: little brown myotis (yellow diamond), northern myotis (pink diamond), eastern red bat (red circle), hoary bat (grey circle), silver-haired bat (black circle), and big brown bat (brown circle). The provincial boundary is defined in black, and the southern boundary of the Far North Ontario region is defined in red. (Ambershaw Metallics Inc., 2019; amec foster wheeler, 2016; Canadian Environmental Assessment Agency, 2018; Harris, 2020; Northern Bioscience, 2020; Stantec Consulting, 2017; wood PLC., 2018)

4 Knowledge Gaps

4.1 Overview

Our knowledge of bats in Far North Ontario is constrained by the limited data available to describe their populations and ecology. Outstanding gaps in our knowledge impedes scientifically sound decision making and impact assessment in a region that is expected to experience significant changes in the near- and long-term. These gaps can be broadly divided into missing baseline knowledge (what species and populations currently exist in the region) knowledge of requirements (what the bats need), and threats impacts (how negative changes affect bats).

Knowledge gaps for Far North Ontario bats can be prioritised based upon their relevance to decision making and different species. Fourteen key knowledge gaps are summarised and prioritised by species in Table 3 below. These gaps are discussed and justified in the remainder of section 4. This list, and evaluations of importance, are based on the best available knowledge but should be regularly revisited as new data emerge.

Table 3: Summary table of Knowledge Gaps for bats in Far North Ontario, and their prioritisation by species. Tri-colored bat is omitted as it is assumed not to occur in the region (see discussion in section 0)

Knowledge Gap		Little Brown Myotis	Northern Myotis	Hoary Bat	Eastern Red Bat	Silver-haired Bat
Baseline Species Distributions and Habitat	Species Distributions	Medium	High	Medium	High	Medium
	Sub-regional Pop. Demographics	High	High	High	High	High
	Sub-regional Population Trends	High	High	High	High	High
	Maternity Roost Locations	High	Medium	Medium	Medium	Medium
	Hibernacula Locations	High	High	Not known to hibernate in Ontario		
	Migration Routes	Not a long-distance migratory species		Medium	Medium	Medium
	Summer Male Habitat Locations	Low	Low	Low	Low	Low
Habitat Requirements	Landscape Scale Maternity Habitat	High	High	High	High	High
	Local Scale Maternity Habitat	High	High	Medium	Medium	Medium
	Landscape Scale Hibernation Habitat	High	High	Not known to hibernate in Ontario		
	Local Scale Hibernation Habitat	Low	Low			
Threats and Impacts	Spread and Impacts of WNS	High	High	Not known to be affected by WNS		
	Impacts of Climate Change	Low	Low	Low	Low	Low
	Resiliency to Habitat Degradation	Medium	Medium	Medium	Medium	Medium

4.2 Baseline Species Distributions and Habitat Occurrence

4.2.1 Species Distributions

Existing data suggest that most, and potentially all, bat species present in Far North Ontario have distributions that encompass only part of the region (section 3). These ranges vary by each species' tolerance for varying landcover and climate at increasing latitudes, and defines the northern extent of their respective ranges (Van Zyll de Jong, 1985). Species distributions are primarily defined by occurrence data and can be refined with models and ground truthing.

Understanding species' ranges is vital for effective conservation and decision making; there is little value in taking actions to protect a species in an area in which it does not, or did not previously, occur. A reliable estimate of what species are expected to occur in an area is needed to inform activities such as impact assessments. Species distribution knowledge informs the methodologies and study designs applied to assess bats and supports effective evaluation of the results.

Existing data on bat occurrences in Far North Ontario provide a preliminary baseline for species distributions. However, this understanding is largely drawn from a single study that presents a snapshot view of activity in a single time period (2010–2014; Layng et al., 2019). An over reliance on these existing data without corroboration, could lead to negative outcomes and dangerous assumptions about species presence or absence.

Refined species distributions are needed for all species in Far North Ontario. Existing data provide moderate insight into the distributions of little brown myotis, hoary bat, and silver-haired bat. However, due to the reliance on acoustic monitoring in existing datasets, there is greater uncertainty regarding distributions for species that are not well represented by such monitoring (see section 3.1.2). Specifically, distribution data are lacking for: northern myotis, a high-frequency low-amplitude echolocator that is difficult to record acoustically; and eastern-red bat, a species that can be difficult to distinguish from other species acoustically. Species distributions vary seasonally, and over time due to factors such as climate change; existing data do not reflect these variations.

This knowledge gap is ranked as medium for species well represented by existing data, and high for species not currently well represented due to its fundamental importance and relevance to other knowledge gaps.

4.2.2 Sub-regional Population Demographics

While distributions define the overall area over which a species is found, they do not account for finer-scale details. Demographic details such as overall population sizes and the breakdown of individuals of different sexes, ages, and reproductive statuses, are all factors that are valuable to define. Identifying these demographics at a sub-regional scale, i.e., at smaller scales within Far North Ontario is beneficial given the heterogeneity of the region at large. The scale of sub-regions considered will require further consideration to define and may need to be defined at different scales depending on the questions being addressed. However, ecoregions could be an effective starting point.

Sub-regional population demographics support impact assessment and decision making by identifying the number and nature of individuals that could be impacted by a proposed change or management action. Without these data it is impossible to quantify impact on a species in a specific area. For example, local impacts of a development differ between an area with a sparse male population and an area densely populated by reproductive females (Broders et al., 2006).

None of the contemporary data available for bats in Far North Ontario gives specific insight into population demographics. Using acoustic monitoring, some inferences could be drawn from relative activity levels and the timing of activity, both within nights and across the season. However, it remains impossible to distinguish basic data about the individuals recorded, such as sex, age, reproductive status, and health, from acoustic monitoring alone. Similarly, numbers of acoustic observations do not directly equate to numbers of individuals present.

Demographic data is a knowledge gap for all bat species in Far North Ontario. Such data are near equally absent for all species. While the nature of demographic data, and approaches to collecting it, vary by species (particularly between hibernating and migratory species) it is a priority in all cases. Sub-regional population sizes should be prioritised, while other demographic factors relate to other knowledge gaps such as habitat occurrence and requirements. Data collection should be prioritised in sub-regions facing imminent change.

This knowledge gap is ranked as high for all species due to the near absence of data on regional population sizes and other demographics for bats throughout Far North Ontario.

4.2.3 Sub-regional Population Trends

Population trend data is a fundamental datapoint for assessing the health and sustainability of a population. Canada's federally endangered bats were all assessed as such due population trend demonstrating declines (e.g. Committee on the Status of Endangered Wildlife in Canada, 2013). In Quebec, analyses of long-term acoustic monitoring data was used to identify population changes attributed to WNS, as well as potential impacts of wind-power developments on long-distance migratory bats (Faure-Lacroix et al., 2020). Long-term patterns in reproductive success can also indicate population health (Lučan et al., 2013).

Sub-regional populations trends support inform decision making and impact assessment by providing an understanding of the overall status of bats in the area, and a context for quantifying prospective impacts. Suitable scale is important for examining impacts, for example, loss of maternity colony habitat would have an extreme impact at the local scale while being irrelevant when considered within the entire Far North Ontario region; such an impact is best considered within a relevant sun-regional scale. The precise definition of regional requires further definition, and will vary with the questions being addressed, but an ecologically relevant scale such as ecoregion is expected to be most relevant.

This knowledge is important to inform decisions that affect species in Far North Ontario. For example, evaluating the impact of a proposed activity may depend on whether bat populations in the sub-region are robust and increasing, versus in decline due to other threats. Bats have multi-decade lifespans (Florko et al., 2017) and low reproductive rates (Wilkinson & South, 2002). This means that many of the short-term changes expected in Ontario's north will have an intragenerational effect on the region's bats. Understanding the impacts of changes in the Far North Ontario region requires a long-term perspective on their populations and a clear baseline of population trends that can be used to identify changes. These data are also valuable to broader decision making in the region because bats, which are sensitive and responsive to change, are strong candidates as environmental indicator species (Russo et al., 2021). The use of bats as bioindicators has been previously proposed as a means to monitor climate change impacts (Lausen, 2006), and the recovery of natural systems from resource extraction impacts (Hawkes & Gerwing, 2019).

The knowledge gap in population trends for bats in Far North Ontario spans across all species present. The problem is potentially greater for species that are not tracked by NHIC, i.e., eastern red bat, hoary bat, and silver-haired bat. However, the dearth of far north records for species that NHIC does track suggests this difference is of little consequence. Data to address this need could be collected by a variety of means and at different times of year, except for long-distance migratory bats which need not be monitored in winter due to their absence from the region. Collecting trend data would likely tie into addressing other knowledge gaps.

This knowledge gap is ranked as high for all species due to the fundamental importance of knowing baseline trends to monitoring changes in populations at all levels.

4.2.4 Maternity Roost Locations

Bat conservation and management frequently focuses on maternity colonies because these locations are key to population survival and viability. Bats reproduce slowly: smaller species such as *Myotis* produce a single offspring annually, while larger bats such as the migratory species produce 2–3 offspring. Maternity roosts are especially important for hibernating species in Ontario: females form maternity colonies of varying sizes, and the accumulation of most or all reproductive females in a local population at a single location makes them vulnerable to disturbance. Such concerns are less acute for eastern red and hoary bats, where females are solitary during maternity, and moderate for silver-haired bats, which form small colonies.

Positively identified maternity roost locations support sound management making and impact assessment by facilitating direct assessment, management, and mitigation of anticipated impacts. Further, knowledge of extant or historic roosts is necessary to address other knowledge gaps such as identifying maternity habitat requirements at different scales.

No extant or historic maternity colony locations in Far North Ontario were available in accessible datasets. It may be feasible to speculatively identify potential maternity colony locations based on existing acoustic data. However, no attempt has been made to date and at the time of writing such inferences are qualitative with no established quantified approaches.

Maternity roosting ecology varies between species. Factors including maternity colony size and location fidelity affect the relative value of historic location data. For example, little brown myotis roosting in buildings frequently return year after year, whereas tree features such as tree cavities and loose bark used by northern myotis are inherently ephemeral. However, roost fidelity in little brown myotis likely varies in the absence of human structures when bats occupy natural roosts.

This knowledge gap is ranked medium for all species except for little brown myotis, which is ranked high due to higher roost fidelity observed in human structures, when available.

4.2.5 Hibernacula Locations

Hibernacula are essential locations to the life histories of hibernating species such as *Myotis* bats. Such species cannot survive without suitable overwintering sites available within an accessible distance. Hibernation ecology for the two hibernating bat species that occur in Far North Ontario overlap and they are frequently found overwintering together. Possibly due to the rarity of suitable overwintering locations, and the near absence in flux in the availability of such features, hibernacula are the least ephemeral habitat resource for bats. This habitat is not relevant to migratory bats, which aren’t known to overwinter in Ontario.

Specific hibernacula locations are valuable for conservation efforts and impact assessment because known locations can be protected most effectively. Such sites can also yield data that support knowledge gaps such as population monitoring and the habitat requirements.

No extant or historic hibernation locations are known in Far North Ontario.

This knowledge gap is ranked as high for both affected species, due to the highly specific nature of hibernacula, their essential role in species life histories, and high fidelity of bats to specific sites.

4.2.6 Migration Routes

Long-distance migratory species such as: the eastern red bat, hoary bat, and silver-haired bat, are thought to travel via specific routes during their seasonal movements, and stopover at specific sites on the way (Baloun et al., 2020; Dzal et al., 2009; McGuire et al., 2012). These behaviours are poorly understood throughout the species ranges due to the difficulties of tracking them and identifying these habitats.

Knowledge of migratory routes supports effective decision making by providing clearer insight into the impacts of proposed changes on migratory bats. This consideration is important because any changes affecting migration sites can disproportionally impact the larger regional population when large numbers of bats that are otherwise distributed across a wider area move through and are impacted.

No data exist to describe the routes used by migratory bats in Far North Ontario. This knowledge gap applies to the three migratory species known in the region.

This knowledge gap is ranked as medium for affected species due to the potential value of migratory route knowledge to the protection of populations in the region.

4.2.7 Summer Male Habitat Locations

Male bats typically roost alone, or in small groups, in less optimal habitat surrounding maternity colonies. Male bats have lower energy demand in the summer because they are not typically involved in rearing pups and need only to survive until the next breeding season in the fall. This allows them to occupy smaller areas of lower quality habitat. Accordingly, males may be found in different areas to females (Broders et al., 2006).

Knowledge of specific male summer habitat supports species conservation and effective decision making primarily by facilitating accurate evaluation of the importance different areas of a species range to species survival. There are no available data to describe summer male habitat in Far North Ontario; this gap applies to all species. Male summer habitat has lower importance than other habitat types with a more direct and immediate link to population survival.

This knowledge gap is ranked as low for all species, due to the apparent flexibility of summer male habitat, and the relatively low ecological demands of males at this time.

4.3 Habitat Requirements

4.3.1 Landscape Scale Maternity Habitat

While the location of specific maternity colonies can be directly used to identify local impacts, individual locations alone have limited value due to the ephemeral nature of many such resources and the difficulty of collecting and applying such knowledge at larger scales. Further, the habitat requirements of reproductive female bat populations extend beyond roost locations alone. Reproductive females have high energy needs and prefer to forage at minimal distance from roosts, with high fidelity to foraging areas (Slough & Jung, 2020). Such habitat is unlikely to be a limiting factor in most areas, compared to suitable roosts. However, the loss of a large proportion of foraging habitat within a typical foraging range of a roost could render the area unsuitable even if roosts are retained. Further, the availability of an appropriate maternity habitat landscape likely constrains the northern extent of the species' ranges, and therefore the species distribution in Far North Ontario. Therefore, a holistic, 'landscape scale' habitat assessment, incorporating both roosting and foraging habitat, offers a more comprehensive and effective approach.

This knowledge gap refers specifically to identifying a general set of requirements for roosting and foraging by reproductive female bats, which can be used to identify landscape scale maternity habitat in Far North Ontario. These definitions would include the area and type of foraging habitat, and type and density of roosting features required. General definitions on the foraging and roosting areas of little brown myotis and northern myotis are suggested by Ontario's provincial recovery strategy (Humphrey, 2019). However, these parameters are defined using limited data for populations primarily in the south of the province. Bats at higher latitudes likely have different foraging requirements, such as larger areas, or making use of different landcover. These needs likely vary between and within species (Broders et al., 2006).

A specific Far North Ontario definition of landscape scale maternity habitat would support effective decision making by allowing evaluations to consider potential impacts of change without necessarily identifying specific habitat features. Further, such knowledge could provide a regional context for assessments. For example, knowing the total area of maternity roosting habitat available in the wider landscape would allow a more effective evaluation of the local loss of such habitat.

The nature of landscape scale maternity habitat will differ between species. For example, species that form large maternity colonies of hundreds of individuals, such as little brown myotis, have different requirements to hoary and eastern red bats, where females remain solitary throughout maternity. However, the availability of suitable landscapes is equally important to all species.

This knowledge gap is ranked as high for all species due to the high importance of suitable maternity habitat to bat reproduction.

4.3.2 Local Scale Maternity Habitat

As identified in sections 4.2.4 and 4.3.1, maternity habitat supports an import life cycle activity for bats. The specific local habitat requirements for maternity roosts are a gap in our knowledge of Far North Ontario bats, beyond the wider maternity landscape considerations discussed above. Local maternity roost habitat includes the structures and features used for this behaviour, and the biophysical characteristics they must possess to be useful to bats.

A description of local maternity habitat is important for decision making. This knowledge supports local assessment through identification of potential habitat and supports assessment at a larger scale by supporting modelling and other approaches to identify the wider availability of suitable habitat and place impacts into context.

Existing research and knowledge of maternity roosts is focused on cavity roosting species, including little brown myotis and northern myotis, which form large maternity colonies with tens or hundreds of bats congregating. However, most data and observations available on the maternity roosts of these species were collected in their southern ranges, with few observations in the boreal forest and none in Far North Ontario. These data could be less relevant in species' northern extremes, where differences in the environment and climatic limitations require local populations to adapt their behaviour. Maternity roosts for long-distance migratory species such as eastern red bat, hoary bat, and to a lesser extent silver-haired bat, present a different value proposition. Females of these species roost alone during their maternity period, except for silver-haired bat which forms small colonies. However, maternity locations are nonetheless essential for these species, even if their dispersed behaviour means the population is less vulnerable to loss of a single location or feature. The solitary nature of these species, combined with the challenge of capturing them and identifying roosts, means their roosting requirements are less understood than most cavity roosting species.

Better understanding the local habitat characteristics of maternity roosts is a high priority for both groups of species. These habitats are highly likely to be impacted by current and impending changes in the Far North Ontario region. For little brown myotis, and non-target species big brown bat, roosting in anthropogenic structures appears to have become preferential, and it has been suggested that human structures in boreal forest might even allow little brown myotis to expand their range (Thomas et al., 2021; Thomas & Jung, 2019). This association with, and potential reliance on, anthropogenic structures bring these species into obvious conflict with human activity, making them directly vulnerable to human activity in the region. For other target species: northern myotis, eastern red bat, hoary bat, and silver-haired bat; data from across the species' ranges suggests that maternity roosts are more likely to occur in natural features, primarily trees, as are little brown myotis when anthropogenic structures are not available. Accordingly, these species are also vulnerable to changes affecting these features, including climate change, forest, and other resource extraction.

This knowledge gap is ranked as high for *Myotis* species due to the concentration of individuals at such locations, and medium for migratory species due to their lower fidelity and tendency to roost along or in small groups.

4.3.3 Landscape Scale Hibernation Habitat

Like maternity roosts, hibernation sites are concentrated congregations of individuals from across a large area, making them highly vulnerable to disturbance. While maternity roosts are important to all species in the Far North Ontario, hibernation sites are only relevant for species that overwinter in the region: little brown myotis and northern myotis. Hibernation sites are an essential resources to which bats show high fidelity (Norquay et al., 2013; Slough & Jung, 2008). Suitable hibernation sites are likely constrained by climate, and modelling suggests that the northern bound for suitable hibernacula of little brown myotis occurs within the Far North Ontario region (Humphries et al., 2002).

Understanding landscape scale habitat needs for hibernation supports effective decision making by identifying areas where this habitat is likely to occur at a larger scale and providing context for the wider availability of this resource. This is useful for both identifying the expected direct impacts of a development and quantifying it within the larger regional context. No current characterisations of landscape scale hibernation habitat for bats in Far North Ontario exists and there are no known locations on which to base an assessment.

This knowledge gap is ranked as high for *Myotis* bats due to the importance of hibernation to their lifecycle.

4.3.4 Local Scale Hibernation Habitat

Local scale hibernation habitat, the immediate surroundings of hibernacula and their internal biophysical features, defines the suitability of specific landscape features for overwintering bats. This knowledge supports decision making and conservation assessments by helping to identify potential habitat locally and providing a means to assess the potential distribution of such habitat at a broader scale. No existing data or assessment of local hibernation habitat exists for bats in Far North Ontario, however, habitat at this scale is likely to be comparable to other regions, where some data do exist.

This knowledge gap is ranked as medium for *Myotis* bats due to the importance of hibernation to their life cycle and the higher applicability of existing knowledge gathered in other regions at this scale.

4.4 Threats and Impacts

4.4.1 Spread and Impacts of White-Nose Syndrome

The proximity of existing WNS observations, within Northern Ontario but south of Far North Ontario (see section 2.3.1) and the demonstrated ability of bats to travel more than 500 km between hibernacula (Norquay et al., 2013) makes it feasible, if not likely, that WNS has already reached the region. Confirming this, and understanding the spread, relies on identification of the fungus through physical swabs or collection of dead bats (Canadian Wildlife Health Cooperative, 2015).

Tracking the potential spread of WNS into the region would inform long-term expectations for population trends, and conservation. This knowledge would also benefit impact assessment and short-term decision making by informing on present or anticipated pressures on local populations. For example: surveys in a location close to, but outside, the WNS infiltration front might indicate a healthy population, but an impact assessment should consider the potential for the disease to arrive within the timeline of the project.

There are no existing data and no known survey effort to date to confirm the presence of WNS in Far North Ontario, nor to define its distribution. This gap is relevant to little brown myotis and northern myotis and is not immediately relevant to migratory bats.

This knowledge gap is ranked as high for affected species due to the acute nature of the threat.

4.4.2 Impacts of Climate Change

Although more research is needed, climate change is expected to impact bat populations in boreal forests (Burns et al., 2015). Potential impacts include long-term changes to species composition and survival, and short-term changes such as increasing forest fires. Knowledge on the response of Far North Ontario bats is relevant to the conservation and management of species in the region as populations' responses to acute and long-term threats interact with their long-term viability and vulnerability to other disturbances.

No data exist to describe the effects of climate change on bats in Far North Ontario. This knowledge gap is relevant to all species in the region, and the impacts are likely to vary among species.

This knowledge gap is ranked as low for all species due to its less acute and defined impacts, however, this ranking should be monitored and revised in future as require.

4.4.3 Resiliency to Habitat Degradation and Loss

To date, bat populations in Far North Ontario have been largely undisturbed by human driven habitat degradation and loss because the inaccessibe nature of the region has prevented any large-scale change or development. However, increasing interest in the natural resources of the north means this situation is beginning to change (Ontario Ministry of Natural Resources, 2015).

Understanding how these changes impact bats in the region is fundamental to impact assessment and larger conservation efforts. There is a clear connection to addressing impacts at the local scale, and this knowledge is also valuable at a larger scale as collective and cumulative impacts are considered. For example: the destruction of a maternity roost by a proposed development might have an acceptable impact, but the loss of multiple such resources in a region could amount to a more significant issue.

No specific data are available to describe the impacts of habitat degradation or loss on bats in Far North Ontario, although pre-construction monitoring for some projects (see section 3.1.8) could become relevant in the future). An extensive collection of studies and observations of bats outside of the region, at various distances south, do exist. Some inferences can be made from this collection of knowledge, and these could be applicable to Far North Ontario, but testing and ground-truthing is required. This understanding is required for all species present in the region.

This knowledge gap is ranked as medium for all species due to the increasing, near-term threat and because also many impacts are likely to be local, larger regional effects may occur and are not well understood.

5 Approaches to Addressing Information Gaps

5.1 Overview

A wide variety of methods and approaches have been developed by researchers studying bats around the world. These range from low cost, non-invasive methods such as Community Science collection of observations, to invasive, expensive, and time-consuming approaches such as radio telemetry to track the movements of individuals bats at a fine scale. Some of these approaches have developed into standardised and widely established methods, while many others, often involving new and emerging technologies, are at an early stage of exploration.

This section proposes and discusses a range of potential methodologies to address knowledge gaps for bats in Far North Ontario. To quantify the relative value of these approaches they were evaluated against the number and priority of knowledge gaps they address (section 4). This evaluation was used to calculate a weighted value for each methodology, with methods that addressed higher priority knowledge gaps scoring higher. The scores from this approach were used to create a ranked list. Where two or more methodologies shared an equal score an objective decision to rank them was made using the author's experience.

Methodologies also vary in the ease with which they can be implemented. Some require minimal investment of money, time, and skills, while others are expensive and challenging to undertake, to the extent that they are be currently unfeasible in Far North Ontario. To address this variation, the various approaches under consideration were ranked for ease of implementation.

The ranked values and east of implementation scores for methodologies are presented in Table 4 below. To present these two ranges a plot was created (Figure 5) to display the relative ranking of each methodology in two dimensions: ease of implementation on the X axis, and value on the Y axis. These potential methodologies are then discussed in detail through the remainder of this section, arranged in four categories:

- Activities to consider implementing immediately, or in the near-term:
    - High Value + Easy Implementation
    - Moderate Value + Easy Implementation
- Activities to consider implementing in future if current difficulties can be addressed:
    - High Value + Difficult Implementation
    - Moderate Value + Difficult Implementation

Note that this approach of objective and subjective rankings is intended to provide a fast and accessible overview of the relative merits and practicality of different methodologies to address knowledge gaps for bats in Far North Ontario. It is not possible to capture all nuances, and readers should review the details for each methodology and adjust for their own application as required.

Table 4: Knowledge gaps for bats in Far North Ontario and proposed methodologies to address them scored by the priority of the gap addressed. The total score for each methodology is summed below and ranked. Ranked ease of implementation is also reported for each methodology, based on subjective assessment.

Knowledge Gap	Priority	Acoustics					Trap+Release				Maternity Roosts		Telemetry		Hibernation			
		Reprocess Far Northern Biodiversity Project Data	Local Short-term Acoustic Studies	Regional Short-term Acoustics Studies	Long-term Acoustic Studies	Improve Acoustic Data Reporting By Proponents	Local Trap+Release	Regional Trap+Release	Proponent Trap+Release	Banding+Recapture Studies	Roost Monitoring	Promote Bat Watch	Radio Telemetry: Myotis	Radio Telemetry: Migrants	Desktop Hibernacula Search	Physical Hibernacula Search	WNS Surveillance	Long-term Hibernation Monitoring
Species Distributions	High / Medium	2.5	2.5	2.5		2.5	2.5	2.5	2.5						2.5			
Sub-regional Pop. Demographics	High				3		3	3	3	3								
Sub-regional Population Trends	High				3					3	3						3	
Maternity Roost Locations	High / Medium										2.5	2.5	2.5	2.5				
Hibernacula Locations	High														3	3		
Migration Routes	Medium		2	2	2	2												
Summer Male Habitat Locations	Low						1	1	1				1	1				
Landscape Scale Maternity Habitat	High						3	3	3				3	3				
Local Scale Maternity Habitat	High / Medium										2.5		2.5	2.5				
Landscape Scale Hibernation Habitat	High														3	3		
Local Scale Hibernation Habitat	Low															1		
Spread and Impacts of WNS	High				3												3	3
Impacts of Climate Change	Low				1													
Resiliency to Habitat Degradation	Medium		2		2	2												
Weighted Value		2.5	6.5	4.5	14	6.5	9.5	9.5	9.5	6	8	2.5	9	9	8.5	7	6	3
Ranked Value		16	10	14	1	11	3	2	4	13	8	17	5	6	7	9	12	15
Ranked Ease of Implemntation		2	5	8	7	4	6	9	10	13	12	1	11	17	3	14	15	16

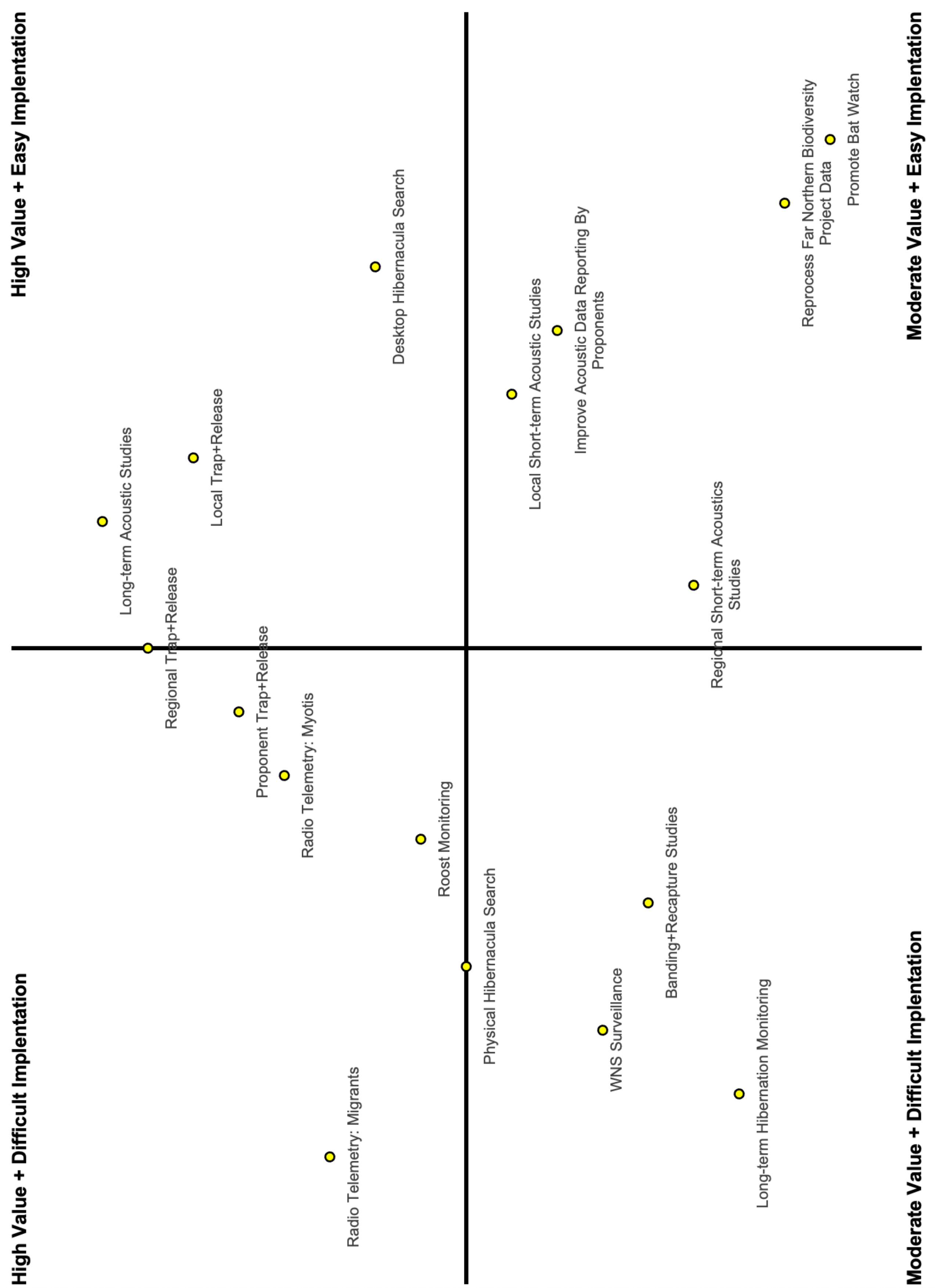

Figure 5: Illustration of relative value and east of implementation of potential activities to address knowledge gaps for bats in Far North Ontario.

5.2 High Value + Easy Implementation

5.2.1 Long-term Acoustic Studies

Equipment Cost:	~$2k per site
Personnel Requirements:	1, intermediately skilled; local contacts
Timeline:	5–10 years
Other Challenges:	Availability of suitable locations
Relevant Species:	All
Primary Knowledge Gaps Addressed:	Sub-regional population dynamics; sub-regional population trends; migration routes; spread and impacts of WNS; impacts of climate change; resiliency to habitat degradation
Other Benefits:	

Bats are long-lived species and understanding their ecology and populations requires long-term monitoring. Acoustic monitoring provides an effective and non-invasive method to monitor the activity of many bat species. Recent technological advancements have increased the feasibility of long-term acoustic monitoring. Where such datasets exist, they have proved invaluable for identifying large-scale changes in bat populations (e.g. Faure-Lacroix et al., 2020; Morningstar et al., 2019).

Long-term acoustic studies can primarily address Far North Ontario bat knowledge gaps involving population change, such as sub-regional population trends, and knowledge gaps surrounding bat populations responding to novel threat such as WNS, climate change and habitat degradation. It is the easiest method to implement that addresses these issues.

These data can be collected using conventional passive acoustic monitors, deployed repeatedly at the same locations. Deployment timescales could involve continuous monitoring or repeated monitoring at a set interval, depending on the resources available and precise questions to be addressed. A more advanced approach could be undertaken at sites with mains power: with a desktop computer connected to a weatherproof, ultrasonic, USB microphone mounted outside the building to monitor continuously. The latter approach requires less ongoing maintenance, and potentially allows data to be collected centrally via the internet with the disadvantage that few suitable locations are available in the region.

Long-term monitoring can be applied at different scales, both local and regional. However, for the purpose of this review long-term monitoring is considered as a single approach due to unlikelihood of deploying extensive long-term monitoring across the entire region, and the unique challenges to long-term monitoring. To address concerns at different scales long-term monitoring could be combined with regional and local acoustic monitoring approaches explored below.

The primary difficulty with long-term acoustic monitoring project in Far North Ontario is the identification of suitable sites at a scale to provide usable data for the region. Monitoring locations need to be accessible for repeated visits. Sites close to human habitat present the easiest avenue to sustainable data collection. Such locations do not represent optimum bat activity, but this can be balanced against ease of access. Tools such as the North American Bat Monitoring Program can be used to guide site selection and analyse resulting data within a larger, international context (Loeb et al., 2015; Reichert et al., 2021).

A second disadvantage to this approach is the long-term commitment required. A minimum commitment 5–10 years should be considered when planning for long-term data collection to be effective. This is beyond the scope of many grant-funded conservation projects. As such, this approach is most practical for government agencies, or could be considered as a monitoring and mitigation component for large-scale, long-term developments in the region.

An investment in long-term acoustic monitoring presents a relatively low-cost approach to address a fundamental knowledge gap on the status of bats in Far North Ontario, with a long-term commitment appropriate to the lifespans of target species.

5.2.2 Local Trap+Release

Equipment Cost:	<$5k
Personnel Requirements:	2, highly skilled + field support
Timeline:	2–8 weeks, in summer
Other Challenges:	Remote travel required
Relevant Species:	All, primarily Myotis
Primary Knowledge Gaps Addressed:	Species distributions; sub-regional population demographics; landscape scale maternity habitat; summer male habitat
Other Benefits:	Opportunity to assess health

Physically handling bats is necessary to address many demographic questions. Catching and handling bats is an invasive and highly skilled activity requiring specialised equipment, permits, animal care approvals, and rabies vaccinations. Trap+release surveys are most likely to benefit *Myotis* species, which are more easily caught. The ecology of eastern red bat, hoary bat, and silver-haired bat makes them more challenging to capture.

Local trap+release, referring to surveys conducted at a small scale at specific areas within the Far North Ontario region, is primarily beneficial for addressing sub-regional population demographics and landscape scale maternity habitat. This is achieved through recording biometrics of captured individuals, which informs on the demographics of local bats, and use of the area by reproductive females if they among the bats captured. This approach also informs on summer male habitat locations when males are present among the captured bats.

Survey locations for this approach could be selected for convenience, for example sites with easy access, or where other surveys are taking place. Locations could also be selected based on direction from other data sources such as acoustic monitoring or habitat modelling.

The primary challenge to trap+release surveys are finding personnel with sufficient experience to safely catch and handle bats, such skills are rare and have a long learning curve, and accessing suitable locations in Far North Ontario to conduct surveys. An effective trap+release survey requires multiple nights in the same area to allow surveys to identify suitable trapping locations, which presents safety and logistical challenges in remote locations. Bats are captured in flight using mist nets or harp traps, and trapping success can be increased with an acoustic lure playing social calls to attract bats. Reports of trapping surveys in other regions of boreal forest suggest that trap+release surveys are viable, despite low capture rates (e.g. Jung et al., 2006; Lausen, 2014; Lausen et al., 2008; Slough & Jung, 2008).

Trap+release surveys are an advanced method, with numerous challenges. However, this is a necessary approach to collect demographic data, and support more advanced methods, and establishing these surveys at a local scale would be a highly valuable effort to improve understanding of bats in Far North Ontario.

5.2.3 Desktop Hibernacula Search

Equipment Cost:	$0
Personnel Requirements:	1, intermediately skilled
Timeline:	<1 year
Other Challenges:	Suitability of available datasets
Relevant Species:	Little brown myotis; northern myotis
Primary Knowledge Gaps Addressed:	Species distributions; hibernation locations; landscape scale hibernacula habitat
Other Benefits:	Resource for future development proposals

Although no hibernacula were identified in the available data for Far North Ontario these sites are relatively well documented, with defined parameters, in other regions. In Ontario, a total of 242 hibernacula observations are recorded by NHIC in the Ontario Shield ecozone, including 69 observations in the Lake Wabigoon, Lake Nipigon, and Pigeon River ecoregions in the northwest of the area. These include several observations within 200 km of the southern limit of the far north region.

Using existing datasets to collate features associated with bat hibernacula in Ontario and search for potential sites in the far north region would be a valuable exercise. This approach primarily addresses the landscape scale hibernacula habitat gap, with additional benefits to species distributions and hibernacula locations by refining search areas and parameters.

A desktop search for potential hibernacula in Far North Ontario could be undertaken by a single person proficient in GIS and spatial modelling. Primary data required to support this approach are location data for known hibernacula in Ontario, and neighbouring boreal forest regions, combined with various existing geospatial datasets such as temperature ranges, land cover, and geology. Additional refinement is possible using more specific characterisations of known sites; however, such characterisations require specific field visits to collect if such data are not available for enough sites. If suitable data are available, the exercise can be completed relatively quickly, though the large size of the region means specific regions should be targeted if required.

Remote identification of potential hibernacula sites will be inherently limited by the available data. However, remote searching for hibernacula has previously proved successful: Dubois and Monson (2007) describe using data sources including: surface geographic, topographic mapping, and aerial photographs to identify karst features associated with potential hibernacula: sinkholes and trenches in areas with limestone, dolomite and gypsum bedrock. Dubois and Monson then visited potential sites to ground truth and confirm locations. Within smaller search areas, thermal imaging from helicopters has been used to identify caves with favourable thermal conditions for bats (pers. com. Dr. Craig Willis, University of Winnipeg, 2022). This approach could also be supported by surveying local knowledge holders.

The biggest drawback to this approach is the requirement to judge suitability based upon remote and incomplete data. This method creates a rapid dataset of potential sites that could be immediately beneficial for proposed development in the region and can be further refined through on the ground activities in the longer-term. This approach primarily addresses the knowledge gap in the habitat requirements for hibernating bats in the region and could also help in addressing knowledge gaps in species distributions.

With suitable data, a desktop search for potential hibernacula requires relatively few resources and provides a quick advancement in understanding of potential bat activity in Far North Ontario and provides a basis for future activities.

5.3 Moderate Value + Easy Implementation

5.3.1 Local Short-term Acoustic Studies

Equipment Cost:	$5–10k
Personnel Requirements:	1 primary, intermediately skilled + field support
Timeline:	<1 year
Other Challenges:	Remote travel required
Relevant Species:	All
Primary Knowledge Gaps Addressed:	Species distributions; migration routes; resiliency to habitat degradation
Other Benefits:	

Short-term acoustic monitoring provides a snapshot of bat presence at a location. These surveys are most valuable for a rapid assessment of bat fauna in an area. Acoustic surveys are effective for most species, with limitations for quiet or ambiguous species (see discussion in section 3.1.1).

Using a similar definition of spatial scale to local trap+release (5.2.2), this method primarily addresses species distributions by contributing observations, and can also contribute to knowledge of migration routes and resiliency to habitat degradation. In the latter case, this method would be most effective if combined with long-term acoustic studies (5.2.1).

The local nature of this approach means studies can be quickly deployed in specific areas of interest within the larger Far North Ontario region. Canadian Wildlife Service recently took this approach in the Ring of Fire region in 2021 (see section 3.1.4).

These surveys can be undertaken with a moderate investment in equipment, depending on the number of sites to be surveyed simultaneously. Survey designs with stationary, automated bat recorders are preferable to mobile transects (Whitby et al., 2014). The timing of data collection will be determined by the questions to be addressed, for example: data associated with summer habitat should be collected in June and July, while addressing migratory routes requires data collection in late summer and fall. Work can be largely planned and conducted by a single person familiar with bat acoustic data collection, with additional personnel required for support and safety during fieldwork. Data analysis can be conducted relatively rapidly be a person familiar with the processing and interpretation of bat acoustic data.

The primary difficulty of this approach is the need to physically access study locations to deploy, maintain, and retrieve equipment. Access is likely challenging for most locations, and monitoring designs require compromise between optimal sampling and feasible travel. This approach can be combined with other fieldwork to avoid planning specific trips. While an experienced individual should be involved in study design and data analyses, the deployment and maintenance of acoustic recording units can be undertaken by other staff or local individuals with minimal training.

Potential priority areas for local short-term acoustic monitoring studies are areas with sparse or no coverage by the Far North Biodiversity Project, and other datasets (Figure 3). Specifically, Lake St. Joseph, western Big Trout Lake, central and western James Bay, eastern Northern Taiga and eastern Hudson Bay Coast ecoregions. Other priorities are areas with imminent development, such as the Ring of Fire mining crescent and surrounding region. Tools such as the North American Bat Monitoring Program can be used to further guide site selection and analyse resulting data within a larger, international context (Loeb et al., 2015; Reichert et al., 2021).

Short-term acoustic monitoring is an easy to implement method for rapid assessment of bat fauna and activity within an area of interest and can be deployed to target specific knowledge gaps and contribute to species distribution data.

5.3.2 Improve Acoustic Data Reporting by Proponents

Equipment Cost:	$0 direct cost
Personnel Requirements:	1, moderately skilled
Timeline:	1+ years
Other Challenges:	Reluctant reporting; no choice of locations
Relevant Species:	All
Primary Knowledge Gaps Addressed:	Species distributions; migration routes; resiliency to habitat degradation
Other Benefits:	

Local acoustic survey data is regularly collected by proponents as part of legislated environmental surveys. These data are closely comparable to local short-term acoustic studies (5.3.1). However, these data are rarely shared in full detail due to concerns over data sensitivity, or simply lack of incentive.

Increasing data reporting and sharing by proponents, would contribute to addressing knowledge gaps in species distribution, migration routes, and resiliency to habitat degradation. This approach is especially effective for addressing the latter knowledge gap because proponent monitoring is likely to be associated with specific habitat impacts and valuable knowledge could be gained with an appropriate study design.

Because such data are already collected by proponents, encouraging data sharing through incentivization or requirement is a low-cost approach to expand the available data on bats in Far North Ontario. Data could be shared by uploading to public databases such as NABat and

BatAMP, or making raw data available for access. Some proponents in the region have indicated an interest in establishing a consistent data sharing approach (see 3.1.8)

Although comparable to local short-term acoustic studies, this approach is ranked marginally lower due to the limited number of proponents and developments in the region, and because such surveys take place in suboptimal locations for addressing the desired knowledge gaps.

Encouraging improved reporting of acoustic offers moderate value but should be considered due to the potential ease of implementation.

5.3.3 Regional Short-term Acoustics

Equipment Cost:	$5–10k
Personnel Requirements:	2, moderately skills + field support
Timeline:	<5 years
Other Challenges:	Extensive remote travel; repeats FNBP
Relevant Species:	All
Primary Knowledge Gaps Addressed:	Species distribution; migration routes
Other Benefits:	Updates distributions

Regional short-term acoustics refers to the same methodology described above as local short-term acoustics (section 5.3.1), applied with a systematic sampling design across the entirety of Far North Ontario. A suitable sample design could be derived from NABat (Loeb et al., 2015; Reichert et al., 2021). Short-term monitoring supplies a snapshot view of species at a particular time; however, this approach could be combined with long-term acoustic studies (5.2.1) to expand the knowledge gaps addressed.

This methodology would primarily address knowledge gaps in the species distribution of bats in the Far North Ontario, as well as contributing to knowledge of migratory routes if data were collected later in the season.

Undertaking this approach would amount to a repeat of the surveys conducted for the Far North Biodiversity project. The scale of data collection required for a comprehensive regional survey would have considerable costs for both equipment and personnel and require extensive travel. This approach would be most feasible if tied to other fieldwork activities, and it could be beneficial to collect these data piecemeal if a full survey is not practical in a short timeline.

The existence of a similar, relatively recent dataset means that any efforts to adopt this approach should consider a compatible study design to allow comparisons to be drawn. This would effectively convert to a long-term acoustic study and contribute to additional knowledge gaps such as sub-regional population trends.

While valuable, extensive regionally stratified acoustic monitoring of bats in Far North Ontario is unlikely to be feasible in the foreseeable future. However, it should be considered as an addition to any future regional surveys planned and could be addressed on a piecemeal basis.

5.3.4 Reprocess Far Northern Biodiversity Project Data

Equipment Cost:	$0
Personnel Requirements:	1, intermediately skilled
Timeline:	6 months
Other Challenges:	Dataset not easily available; age of data
Relevant Species:	All
Primary Knowledge Gaps Addressed:	Species distributions
Other Benefits:	Large geographic scope

Acoustic monitoring data collected during the Far North Biodiversity project remain the only regional dataset for bats in Far North Ontario. The raw dataset is not currently available for further examination or comparison, and the outcomes of this monitoring are only accessible through the analysis and results presented by Layng et al (2019). This paper presents an excellent overview and interpretation of the data. However, analysis and interpretation of bat acoustic data is a rapidly evolving field, and methods have improved even in the short time since these data were processed and published.

Reprocessing these data with updated classifiers, and undertaking additional manual verification of identifications, would refine the major dataset contributing to knowledge of species distributions in Far North Ontario. Specifically, it would be beneficial to resolve uncertainties around species that are challenging to accurately identify acoustically, such as differentiating between big brown and silver-haired bats, and among *Myotis* species. It would further serve to resolve doubts over the veracity of observations of tri-colored bat in Far North Ontario.

Reprocessing the data with modern software would be a relatively easy desk-based activity with no travel or equipment (beyond software) required. The work could be undertaken in a short timeframe by a single person proficient in analysing and interpreting acoustic datasets. The processed data could be shared to public databases such as NABat and BatAMP for future use.

The major impediment to this action is the current unavailability of the data. The Ministry of Northern Development, Mines, Natural Resources and Forestry has indicated an openness to sharing data, however, the data require significant organisation and quality assurance before they can be shared and the Ministry does not currently have a viable business case to commit staff time to that work (pers. com. Philip DeWitt, MNRF, 2021). Aside from practical challenges, the biggest disadvantage to this approach is the age of the data, which was collected in 2011–2014, since when the situation may have changed significantly.

This approach could also be combined with other regional short-term acoustic studies (5.3.1), or with long-term acoustic studies (5.2.1), to contribute knowledge on population trends. With this approach limitations, such as differences between equipment and local conditions would need to be addressed.

If data access difficulties can be overcome rapid, updated analyses would provide a quick and easy payoff. Although the data are relatively old, they provide a strong foundation for future investigations.

5.3.5 Promote Bat Watch

Equipment Cost:	$0
Personnel Requirements:	1, low skilled
Timeline:	1+ years
Other Challenges:	Low population density, biased to settlements
Relevant Species:	Little brown myotis
Primary Knowledge Gaps Addressed:	Maternity roost locations
Other Benefits:	Public engagement

Neighbourhood Bat Watch is a Community Science project that encourages the public to report observations of bats and roosts. Promoting this project would contribute knowledge to address knowledge gaps in maternity roost locations, primarily for species that roost in buildings.

The Neighbourhood Bat Watch website and infrastructure already exist meaning this approach can be implemented minimal cost, possibly as part of other outreach or communication activities with addition public engagement benefits. However, value of this approach is inherently limited by the low population density in Far North Ontario. Value is also limited by the number of species addressed.

Promoting bat watch among communities in Far North Ontario offers relatively low value, but for minimal cost.

5.4 High Value + Difficult Implementation

5.4.1 Regional Trap+Release

Equipment Cost:	$5–10k
Personnel Requirements:	6, highly skilled + field support
Timeline:	<5 years
Other Challenges:	Overnight remote travel with bulky equipment
Relevant Species:	All, primarily myotis
Primary Knowledge Gaps Addressed:	Species distributions; sub-regional population demographics; landscape scale maternity habitat; summer male habitat
Other Benefits:	Widespread insight into bat health

Regional trap+release refers to an application of the methodology described above for local trap+release (section 0), with a systematic sampling design across the entirety of Far North Ontario. This approach would comprehensively address knowledge gaps species distributions and sub-regional population demographics, with additional benefits to revealing summer male habitat locations and landscape scale maternity habitat if males or reproductive females are among the bats captured.

This approach combines the access challenges discussed for regional short-term acoustic studies (5.3.3) and other challenges of capture surveys (5.2.2) and would be expensive and time-consuming to implement. Further, the resources required to access many areas, such as the far north of the region, might be better spent on surveys in areas where greater numbers of bats are suspected. A full regional deployment of trap+release surveys is likely unfeasible, but this approach could be completed at lower density or in part and combined with other fieldwork to reduce access difficulties.

A comprehensive, stratified regional trap+release survey for bats in Far North Ontario is unlikely to be feasible due to cost and other practical constraints. However, this approach offers considerable value and could be considered in part or in combination with other activities.

5.4.2 Proponent Trap+Release

Equipment Cost:	$0 direct cost
Personnel Requirements:	1 moderately skilled
Timeline:	1+ years
Other Challenges:	Consultants are unlikely to obtain provincial Wildlife Scientific Collectors Authorisations currently; no choice of locations
Relevant Species:	All, primarily *Myotis*
Primary Knowledge Gaps Addressed:	Species distributions; sub-regional population demographics; landscape scale maternity habitat; summer male habitat
Other Benefits:	Opportunity to assess health

This approach is effectively the same as the local trap+release methodology described above (0), however, conducted as a component of proponent environmental assessments. This approach has similar advantages to local trap+release surveys, with the costs and logistics organised by the proponent. This approach has the further advantage of more comprehensive assessments and better information for proponents ahead of development.

Beyond the challenges described for local trap+release above (0), the main difficulty of this approach is the difficulty of obtaining permits for proponent surveys occurring on land under Ontario's provincial jurisdiction. To date, the Ministry of Northern Development, Mines, Natural Resources and Forestry has not issued Wildlife Scientific Collectors Authorisations for bat capture for any commercial ecology study.

Proponent trap+release surveys would be a valuable approach to increase knowledge of demographics and distributions of bats in Far North Ontario. However, it not feasible unless the province is able to issue permits for commercial trap+release surveys.

5.4.3 Radio Telemetry: Myotis

Equipment Cost:	$5–10k
Personnel Requirements:	2 highly skilled, 2 moderately skilled + field support
Timeline:	2 + years
Other Challenges:	Bats would be extremely difficult to follow in remote terrain
Relevant Species:	Little brown myotis; northern myotis
Primary Knowledge Gaps Addressed:	Maternity roost locations; landscape scale maternity habitat; local scale maternity habitat; summer male habitat locations
Other Benefits:	

Radio telemetry involves attaching small radio transmitters to bats, and tracking the signal emitted to follow the bats' location in real-time. This is an invasive approach that requires that bats be captured before transmitters are applied using glue and remain attached for approximately 10–20 days before detaching. Radio transmitters are required to weigh less than five percent of an animal's bodyweight and for most temperate bat species this limits radio tracking to simple transmitters that emit a radio plus at an interval of several seconds. Bats are located using an appropriate radio-receiver and directional or omnidirectional antennae. Tracking is typically conducted manually, requiring significant personnel to follow each bat. Recent developments involve the use of a network of automated receivers to track animals with transmitters, however, this is a novel method and requires many well-positioned receivers to produce effective results.

Radio telemetry of *Myotis* species would contribute knowledge addressing maternity knowledge gaps or male summer habitat locations, depending on the individuals targeted. Tracking females to target maternity offers the greatest return, and would contribute knowledge on specific maternity roost locations, as well as landscape and local scale maternity habitat through identifying home ranges and preferences for different land covers and landscape features.

While automated tracking is a developing method, radio telemetry of bats is otherwise an established technique. The main challenge to implementation is the difficulty of tracking bats or installing automated telemetry equipment in the challenging terrain of Far North Ontario, especially in areas without trails or roads. Radio telemetry is also particularly difficult in dense forests. Therefore, radio telemetry could be impossible in many areas of Far North Ontario. This approach also requires locations where species of interest can be reliably captured.

Radio telemetry of *Myotis* species would provide incomparable insight into the foraging and roosting activity of these species. However, the extensive challenges associated with this approach will severely limit its application in Far North Ontario or prevent it entirely. This approach is worth considering in any areas of interest where suitable access is available.

5.4.4 Radio telemetry: Migrants

Equipment Cost:	$5–10k
Personnel Requirements:	2 highly skilled, 2 moderately skilled + field support
Timeline:	2+ years
Other Challenges:	Anticipated range size; bats would be extremely difficult to follow in remote terrain
Relevant Species:	Eastern red bat; hoary bat; silver-haired bat
Primary Knowledge Gaps Addressed:	Maternity roost locations; landscape scale maternity habitat; local scale maternity habitat; summer male habitat locations
Other Benefits:	

Radio telemetry of migrant bat species: eastern red bat, hoary bat, and silver-haired bats, involves similar benefits and challenges to those described for *Myotis* (see section 5.4.2), with slightly lower overall value due to the solitary and ephemeral nature of roosts for many of these species. The challenge of telemetry for these species is further challenged by the difficulty of catching individuals to apply transmitters.

Radio telemetry of migrant species would address some knowledge gaps, but less than other activities and with considerable implementation challenges. It should be considered, but not prioritised.

5.4.5 Roost Monitoring

Equipment Cost:	>$2k
Personnel Requirements:	2+, moderately skilled + field support
Timeline:	2+ years
Other Challenges:	Requires known roosts
Relevant Species:	Little brown myotis;
Primary Knowledge Gaps Addressed:	Sub-regional population trends; maternity roost locations; local scale maternity habitat
Other Benefits:	Public engagement opportunity

Roost monitoring, through regular emergence counts, can contribute basic trend data on bat populations at known maternity roosts. This is primarily applicable to little brown myotis: the only species in the region that regularly forms maternity colonies in anthropogenic structures, which have the greatest possibility of roost monitoring. Roost monitoring is often challenging for tree roosts, where most bats in Far North Ontario are likely to occur. Roost monitoring is an effective approach to address sub-regional population trends, maternity roost locations and local scale maternity habitat.

Roost monitoring through emergence counts is an easy approach to implement when roosts are known. Minimal training is required to collect data, and thus this approach could be established with local participants. However, this approach is limited by the need to identify suitable roosts, and none are currently known Far North Ontario. Further limitations are the challenges and inaccuracy of emergence counts, although this can be addressed in part using thermal or near-infrared videography to observe bats.

Roost monitoring is a component of the Neighbourhood Bat Watch program (see section 5.3.5), and its value could be increased by combining with banding+recapture studies (see section 5.5.1).

Roost monitoring offers moderate value but is easy to implement and should be considered if roosts are identified in Far North Ontario.

5.5 Moderate Value + Difficult Implementation

5.5.1 Physical Hibernation Search

Equipment Cost:	<$2k
Personnel Requirements:	2 highly skilled + field support
Timeline:	2+ years
Other Challenges:	Remote, possibly winter, travel required
Relevant Species:	Little brown myotis; northern myotis
Primary Knowledge Gaps Addressed:	Hibernacula locations; landscape scale hibernation habitat; local scale hibernation habitat
Other Benefits:	Could be added to development proposals

This approach is intended as a follow up to the desktop exercise of identifying potential hibernacula using remote data, described in section 5.2.2, although it could be conducted independently of that exercise if potential locations are otherwise identified. This methodology primarily addresses knowledge gaps surrounding hibernation habitat and contributes to knowledge of bat distribution and demographics in the region.

An on-the-ground physical hibernacula search primarily addresses the current knowledge gap in hibernacula location by definitively identifying locations. This method can also contribute knowledge to landscape and local scale hibernation habitat knowledge gaps by gathering data to refine these assessments.

This approach requires a skilled individual familiar with bat hibernation sites to conduct on-the-ground surveys to check potential hibernacula. Dubois and Monson (2007) describe a search methodology that was proved effective. Other tools such as thermal imaging cameras can be useful to identify caves with suitable thermal characteristics, during winter surveys (pers. com. Dr. Craig Willis, University of Winnipeg, 2022).

The main difficulty of this approach is the difficulty of accessing potential locations within Far North Ontario, especially in winter. Physical surveys are further challenged by health and safety constraints around human access to caves and other underground sites, if they are accessible at all. Finally, bat safety concerns over the potential spread of WNS are of considerable concern when accessing potential hibernacula. This is particularly the case in Far North Ontario, where WNS might not yet be established.

Many of these concerns could be addressed using acoustic monitors to assess bat activity at potential hibernacula. Conventional acoustic monitors would be ineffective, due to high power consumption and greatly reduced battery life in cold conditions. However, the Anabat Roost Logger, produced by Titley Electronics (Australia) is specifically designed for long-term monitoring in hibernacula and could be suitable. In this case, monitors could be deployed in fall or early winter, and retrieved in spring for data analysis.

Physical searches for hibernacula in Far North Ontario would provide invaluable data to address knowledge gaps around this habitat requirement. These surveys would be challenging to conduct, but this difficulty could be mitigated in part through novel approaches such as specialised acoustic monitoring. This activity is unlikely to be feasible at a large scale but should be considered on a localised basis when opportunities arise.

5.5.2 White-Nose Syndrome Surveillance

Equipment Cost:	<$2k
Personnel Requirements:	2, highly skilled
Timeline:	1+ years
Other Challenges:	Requires known locations; remote winter travel required; safety concerns for underground site access; risk of spreading WNS
Relevant Species:	Little brown myotis; northern myotis
Primary Knowledge Gaps Addressed:	Sub-regional population trends; spread and impacts of WNS
Other Benefits:	

The Canadian Wildlife Health Cooperative (2015) provides a detailed methodology for conducting WNS surveys in hibernacula. These surveys, to be conducted between November and May, use observations of live and dead bats, bats with apparent fungal growth, and swabs to track the occurrence of WNS.

This methodology primarily addresses gaps in knowledge of the spread and impacts of WNS, by identifying infection locations. Far North Ontario likely contains the infection front for WNS in Ontario, making it a high priority area to survey. It also contributes knowledge to sub-regional population trends by informing on infection and associated declines in populations.

There are several difficulties with implementing this approach. Primarily, the current absence of any known sites in the region precludes WNS monitoring. If suitable sites are identified in future, WNS surveys would remain constrained by health and safety concerns over human access to caves and underground sites, and bat health concerns over the potential to transmit WNS between locations.

WNS surveys are not practical at the current time but should be considered in future if suitable sites can be identified.

5.5.3 Banding+Recapture Studies

Equipment Cost:	<$2k
Personnel Requirements:	1+ highly skilled
Timeline:	3+ years
Other Challenges:	Requires known roosts; unlikely to recapture long-distance migrations
Relevant Species:	Little brown myotis; northern myotis
Primary Knowledge Gaps Addressed:	Sub-regional population demographics; sub-regional population trends
Other Benefits:	

Bat banding studies involve marking individuals using metal wing bands, to facilitate future identification if recaptured (sub-dermal PIT tags can also be injected as an alternative to wing bands). This method can be considered as an addition to roost monitoring (see section 5.4.4) and requires capture and handling of bats by a skilled individual. Banding of bats captured in other trapping activities (section 5.2.2, 5.4.1, and 5.4.2) can also be considered; however, the likelihood of recapture and benefits must be weighed against potential risks to the bats.

Banding studies can provide valuable insights into sub-regional population trends and demographics by collecting data on the survival and health of known individuals. These data would be impossible to collect without banding.

This approach involves a long-term commitment that make take several years to provide results. Beyond timescale, the primary challenge to banding+recapture studies are the difficulty of identifying suitable locations, accessing them on an ongoing basis. Such studies are most effective at maternity roosts or swarming and hibernation sites, where bats can be recaptured across multiple years. Suitable locations are challenging to locate.

A further consideration for banding studies is the risk of injuries to banded bats. Injuries ranging from minor to severe have been observed, though detailed data are rarely published. Pursuing this approach requires a considered review of potential benefits and costs to the species involved.

Banding+recapture studies require a long-term commitment and access to suitable sites, making this approach difficult to implement currently. However, this approach should be considered in future if suitable opportunities arise.

5.5.4 Long-term Hibernation Monitoring

Equipment Cost:	$2–10k
Personnel Requirements:	2+ moderately skilled + field support
Timeline:	3+ years
Other Challenges:	Extensive remote travel, likely during winter; human safety concerns; WNS transmission concerns
Relevant Species:	Little brown myotis; northern myotis
Primary Knowledge Gaps Addressed:	Spread and impacts of WNS
Other Benefits:	Tie in to WNS monitoring

Long-term monitoring of bats at hibernacula, such as annual counts, would provide valuable data on the spread and impacts of WNS in Far North Ontario. This approach is currently limited by the absence of any known sites in the region currently but could be implemented in future in conjunction with physical searches for hibernacula (5.4.4) and WNS surveillance (5.4.4). Like physical hibernacula searches, long-term monitoring would be constrained by human and bat health concerns limiting site access. However, it may be possible to conduct safe monitoring using the acoustic approach outlined in section 5.4.4.

Long-term monitoring of hibernacula would provide valuable data on the long-term population trends of relevant species in Far North Ontario. While not currently practical, it should be considered in future if opportunities arise.

6 Wrap-up

Addressing the conservation needs of bats in Far North Ontario, and understanding the impacts of anticipated threats, is challenging for two key reasons: the limited data available to describe the current populations, and the difficulty of collecting new data to address knowledge gaps. Existing data give preliminary insight into species distributions, but this remains a basic and significant knowledge gap, combined with population trends and demographics, for which there a no data at all. Further knowledge gaps exist around the habitat requirements of bats in the region. These can be prioritised based on factors such as specificity: maternity roosts and hibernacula appear to be limiting factors for some species and a greater understanding of these resource should be prioritised. Finally, significant knowledge gaps exist around the anticipated response of bats in Far North Ontario to anticipated threats such as white-nose syndrome, climate change, and habitat degradation and loss. The number of knowledge gaps demands prioritisation, but this should not occlude the long-term importance of addressing them all.

A variety of established and emerging methods exist to address the gaps in our knowledge of bats in Far North Ontario. While the available methodologies vary in their relative value and practicality of implementation, easy-high value activities such as long-term acoustic studies (at local or regional scales), local trap+release studies and a desktop search for potential hibernacula should be prioritised in the short-term. Activities with lower value or higher difficultly should be considered as part of a long-term plan.

In conclusion, the near absence of knowledge about bats in Far North Ontario, 42% of Ontario’s area, presents a considerable challenge. It also presents a considerable opportunity. Effective investment of effort now will support effective management for these species as human activity in the north increases, as well as supporting the wider international effort to keep these species on the map

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