FAWN RIVER INDIGENOUS PROTECTED AREA ECOLOGICAL ATLAS

CHERYL CHETKIEWICZ, CLAIRE FARRELL,
CONSTANCE O'CONNOR,
LORNA HARRIS AND MEG SOUTHEE

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WCS Canada

Wildlife Conservation Society Canada
344 Bloor Street West, Suite 204
Toronto, Ontario M5S 3A7
www.wcscanada.org

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Wildlife Conservation Society Canada (WCS Canada) was incorporated as a conservation organization in Canada in July 2004. Its mission is to save wildlife and wildlands by improving our understanding of — and seeking solutions to — critical problems that threaten vulnerable species and large wild ecosystems throughout Canada. WCS Canada implements and supports comprehensive field studies to gather information on the ecology and behavior of wildlife. Then, it applies that information to resolve key conservation problems by working with a broad array of rights-holders and stakeholders, including Indigenous communities, conservation groups, regulatory agencies, and commercial interests. It also provides technical assistance and biological expertise to local groups and agencies that lack the resources to tackle conservation dilemmas. Already, WCS Canada has worked on design of protected areas (Nahanni National Park), monitoring and recovery of species (grizzly bear, lynx, wolverine, and woodland caribou), restoration of ecosystems, integrated management of large landscapes, and Indigenous community-led community-based conservation.

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The purpose of the WCS Canada Conservation Reports Series is to provide an outlet for timely reports on WCS Canada conservation projects.

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ACKNOWLEDGEMENTS

The Fawn River Indigenous Protected Area (IPA) Ecological Atlas is the product of a collaboration between Kitchenuhmaykoosib Inninuwug (KI) and Wildlife Conservation Society (WCS) Canada. Our goal in producing the Atlas was to continue to advance scientific support for the Fawn River IPA in order to complement and advance KI's vision for protecting their homelands. We are grateful to the community and leadership of KI and their neighbouring First Nation communities who have taken care of these lands, fish, wildlife, waters and relatives since time beyond memory. Cheryl Chetkiewicz is particularly grateful to Jacob Ostaman who was the KI Director for Lands and Resources during the initiation of this project and provided support and encouragement.

This Atlas attempts to describe some of the relationships to the land maintained and cultivated by KI and their neighbours from a scientific perspective. The purpose of the Atlas is to: 1) advance the scientific case for the Fawn River IPA by reviewing, synthesizing, assembling and sharing the available scientific information on species, ecosystems and ecosystem services in the Fawn River IPA; 2) describe the ecological diversity of the Fawn River IPA; 3) support KI jurisdiction, stewardship and keeping the land[1] (conservation and protection) within and around the Fawn River IPA; and 4) share recommendations for research, monitoring and conservation in the Fawn River IPA to spur community-based research and monitoring of fish, birds, mammals, peatland and freshwater functions, as well as further research of the impacts of land use, such as mineral exploration and climate change. While the primary audience for this work is KI community members, leadership and staff, this work complements KI's Cultural Atlas and will likely be of interest to different groups focused on conservation and development throughout northern Ontario.

The Atlas draws on the expertise of WCS Canada scientists who specialize in fish and freshwater ecosystems, birds, mammals, terrestrial and peatland ecosystems. Contributions by Dr. Connie O'Connor, Claire Farrell, Dr. Lorna Harris and Dr. Cheryl Chetkiewicz are based on our understanding and knowledge of the scientific literature relevant to the region even though none of us have been on the ground in the Fawn River IPA. Meg Southee created the maps used extensively throughout the report to support our review. We are grateful for the beautiful illustrations in the fish, bird and mammal sections that were created by Dr. Lucy Poley.

This work was generously funded by The W. Garfield Weston Foundation. Cheryl Chetkiewicz also received funding from the Ontario Trillium Foundation, Consecon Foundation, and from KI as part of the Canada Nature Fund Target 1 Challenge managed by Environment and Climate Change Canada.

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[1] Scientific and non-Indigenous words like protection and conservation need to be understood with respect to KI's law which arises out of the community's relationship with the land. This relationship and law is embodied in the concept of Kanawayandan D'aaki – to protect and to keep the land. This relationship is understood as a sacred duty and fulfilling this duty is part of the responsibility and identity of the KI community.

ABOUT THE AUTHORS

Cheryl Chetkiewicz

Dr. Cheryl Chetkiewicz is an ecologist with a passion for nature and conservation. She earned a Ph.D. in Ecology at University of Alberta for her work on landscape connectivity for grizzly bears and mountain lions in the Canadian Rocky Mountains. She is currently the Director for Communities and Conservation at WCS Canada where she supports the relationships between scientists and communities engaged in impact assessment, land-use planning and research and monitoring. She uses her work to inform both policy and management as well as contribute to reconciliation with Indigenous Peoples. When she is not working to conserve wildlife and building relationships with Indigenous communities, she can be found at home exploring nature with her husband and dog.

Claire Farrell

Claire Farrell is an ecologist with WCS Canada who works on conservation research projects and youth programming. She earned both her B.Sc. in environmental science and M.Sc. in biology at Carleton University. Claire's love of wildlife and the boreal forest is reflected in the species she has worked with: filling knowledge gaps in at-risk species conservation for species such as Common Nighthawk, Eastern Whip-poor-will, boreal caribou and namew (lake sturgeon). Claire has experience in bird-based landscape ecology, cumulative effects and fisheries research methods and analysis, but has most recently co-led Indigenous youth programming alongside Moose Cree First Nation Resource Protection (MCFN). This project, which brings Claire much joy, focuses on combining Indigenous Traditional Ecological Knowledge with western scientific learning as part of MCFN's and WCS Canada's Learning from Lake Sturgeon Program. In her time off, Claire enjoys canoeing, fishing, watching movies and trying out new recipes with perfect cups of tea.

Constance O'Connor

Dr. Constance O'Connor is an ecologist with a lifelong passion for fish and freshwater ecosystems. She earned her B.Sc. in biology and English literature at McGill University and her Ph.D. in biology at Carleton University and then held a postdoctoral fellowship at McMaster University. She is currently the Director of the Ontario Northern Boreal Landscape Program with WCS Canada. She is also an adjunct professor of biology at Lakehead University in Thunder Bay and Laurentian University in Sudbury. Some of her current program highlights include leading a lake sturgeon monitoring program in collaboration with Moose Cree First Nation; identifying priority areas for biodiversity using conservation planning tools; and applying research results to improve planning, management and policy. When she's not solving these scientific puzzles, Connie enjoys exploring the beautiful landscape around her home in northern Ontario by foot and canoe with her young family.

Lorna Harris

Dr. Lorna Harris is the Forests, Peatlands and Climate Change Scientist at WCS Canada. Lorna is studying the ecology, hydrology and biogeochemistry of peatlands and forests in North America's boreal zone and working on improving links between science and policy for the better protection and management of peatlands. Lorna completed her Ph.D. at McGill University where her research focused on the ecohydrology and biogeochemistry of the vast peatlands of the Hudson Bay Lowlands in northern Ontario. Lorna's studies of peatland ecohydrology and carbon dynamics, including in permafrost landscapes impacted by wildfire, continued for her postdoctoral research. Prior to moving to Canada for her Ph.D., Lorna worked as a Wetland Project Officer and a Senior Scientist for the Environment Agency of England and Wales for one year, then as a Wetland Ecologist and Senior Scientist for the Scottish Environment Protection Agency for six years. Lorna enjoys exploring the great outdoors, often with her camera to capture photos of tiny mosses and other plants and wildlife along the way.

Meg Southee

Meg Southee is the GIS Analyst and Spatial Data Manager for the Ontario Northern Boreal Landscape Program at WCS Canada. She is a Certified GIS Professional (GISP®) accredited by the GIS Certification Institute and an Esri Certified ArcGIS Desktop Professional. She has earned a B.Sc. Honours in environmental science from the University of Guelph, a M.Sc. in geography from Queen's University and an Advanced Diploma in geographic information systems from the Centre of Geographic Sciences in Nova Scotia. Meg enjoys walking her two dogs, making preserves, canoeing and exploring the great outdoors.

(Credit: Allan Lissner)

1. INTRODUCTION

The Fawn River Indigenous Protected Area (IPA) is the area encompassed by the Fawn River Watershed within Kitchenuhmaykoosib Inninuwug's (KI) homelands, including the KI Water Declaration Area (KIWDA)(Figure 1). The ecology and ecological values associated with the Fawn River IPA – together with the KIWDA – are determined primarily by the two large ecozones the IPA straddles (with ecozones being large areas determined by "a distinctive bedrock domain that differs in origin and chemistry from the bedrock domain immediately adjacent to it") (Crins et al. 2009). In the case of the Fawn River IPA, these two ecozones are the Hudson Bay Lowlands (HBL) and the Ontario Shield (Crins et al. 2009).

The Fawn River IPA is an assertion of the inherent jurisdiction and governance of KI and other First Nations, including Wapekeka First Nation, across their homelands in what is now known as northern Ontario. KI and their neighbours have lived, thrived and co-existed in relationship to the waters, forests, animals, rocks, sky, plants and other relatives across their homelands since time beyond memory. Alongside economies based on Indigenous worldviews and grounded in Natural Law, their diligent and respectful approaches to maintaining and cultivating biological diversity has been firmly based on the role of people as part of and stewards of these ecosystems, rather than separate from them. The result is an abundant and thriving biological diversity that we as conservation scientists have only begun to understand and describe in this first iteration of the Fawn River IPA Ecological Atlas.

The Fawn River IPA is part of a larger network of provincially protected areas and conservation reserves that includes the Fawn River Provincial Park and Severn River Provincial Park (Figure 2). These provincial protected areas, established under Ontario's *Provincial Parks and Conservation Reserves Act, 2006* (PPCRA 2006), confer some level of legal protection to the fish, birds, mammals and ecosystems that KI and their neighbouring First Nations depend upon. While the purpose of the PPCRA is to, "permanently protect a system of provincial parks and conservation reserves that includes ecosystems that are representative of all of Ontario's natural regions, protects provincially significant elements of Ontario's natural and cultural heritage, maintains biodiversity and provides opportunities for compatible, ecologically sustainable recreation," these provincial parks and conservation reserves were not created with the free, prior and informed consent of KI or their neighbours.

Figure 1. The location of Fawn River IPA and the KIWDA with existing protected areas and conservation reserves and relevant terrestrial features such as ecozones and eskers.

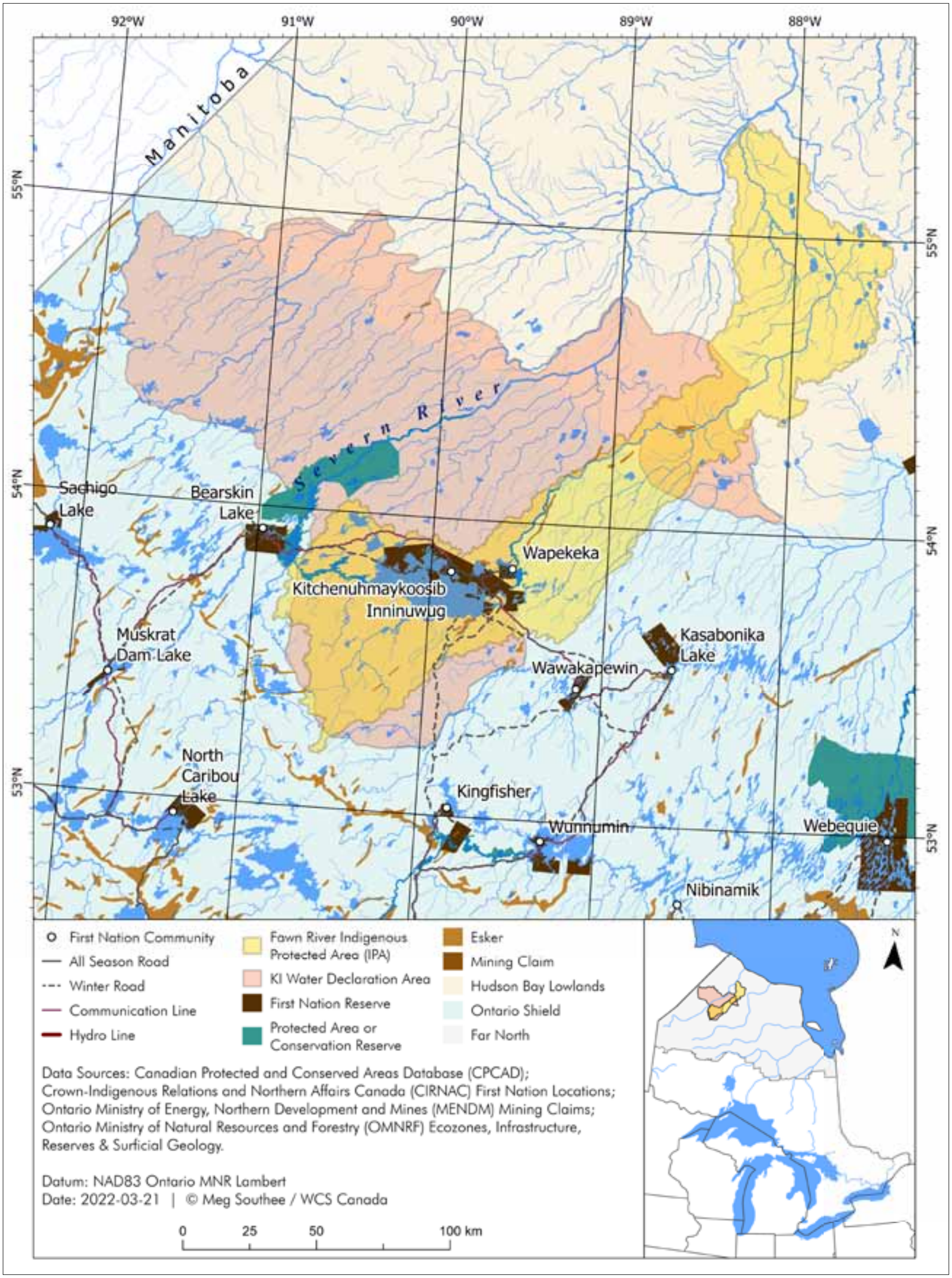
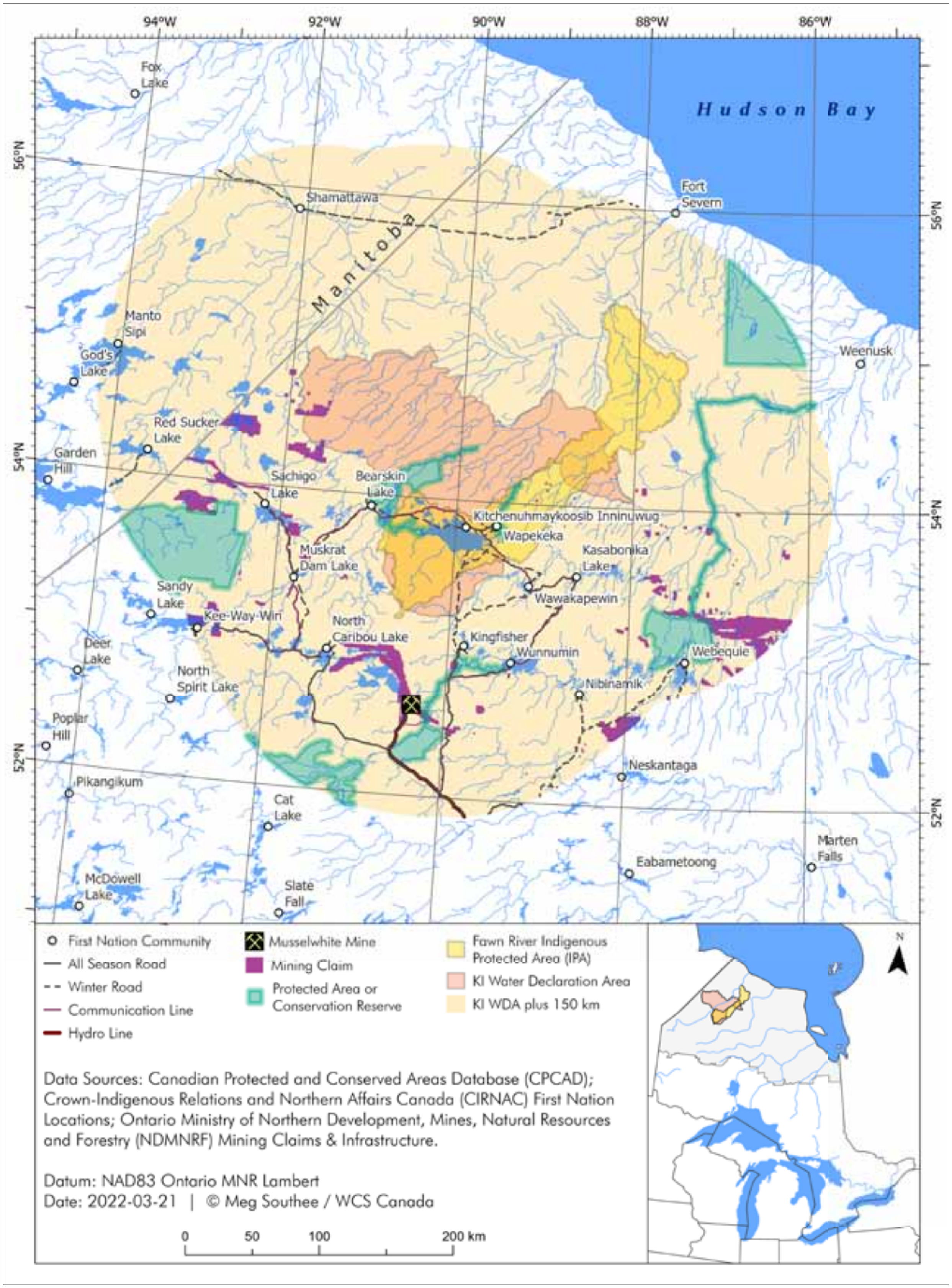


Figure 2. The location of the Fawn River IPA, the KIWDA, and the broadest spatial extent considered in this report in relation to provincial protected areas and conservation reserves as well as other land uses including winter roads, mines, and mineral claims.



At the same time, the Government of Canada has more recently committed to increasing the level of formal land and water protection nationally under various agreements signed within the framework of the Convention on Biological Diversity (CBD). While there are some provisions within the CBD for engaging Indigenous Peoples and seeking their perspectives on protecting and conserving biodiversity – such as Articles 8 (j) and 10(c) on the role and inclusion of traditional knowledge and cultural practices – the pathway to increasing Canada's formal protection of lands and waters has largely been driven by state-negotiated conservation area targets, including the 2020 Aichi Targets (CBD 2020) and, more recently, the 25% by 2025 and 30% by 2030 targets set by the Canada Target 1 Challenge (Government of Canada 2021).

(Credit: Allan Lissner)

The role of First Nations and other Indigenous Peoples in this protected-area process has been limited, however, despite Canada's stated commitments to the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) (UN 2011), the Calls to Action by the Truth and Reconciliation Commission of Canada (Truth and Reconciliation Commission of Canada 2015), 58 Calls to Justice in the national report on Murdered and Missing Indigenous Women and Girls (National Inquiry into Missing and Murdered Indigenous Women and Girls (Canada) 2019), the 2017 Federal Principles for the Government of Canada's Relationship with Indigenous Peoples (Department of Justice, Canada 2017), the over 400 recommendations made by the 1996 Royal Commission on the Aboriginal Peoples as well as the future government action identified in 1998 (RCAP 1996). Ontario has been largely silent on these critical issues and has not actively pursued the development of more equitable and respectful relationships with Indigenous Peoples by taking up these recommendations.

In 2018, the Indigenous Circle of Experts (ICE) released their report, *We Rise Together* (ICE 2018), that described the relationships between Indigenous Peoples and settlers across Canada with respect to the protection and conservation of land and waters, species and ecosystems and the ecosystem services they provide to people. Their report highlights and affirms that not only do Indigenous Peoples across Canada have something to offer regarding biodiversity conservation, protection and promotion, but that the only way forward for governments, non-governmental organizations and others to at least meet area conservation targets must be to formally recognize the responsibilities and roles of Indigenous Peoples and Indigenous Knowledge Systems in the process.

Indigenous Protected and Conserved Areas, as defined by Indigenous Peoples and communities, represent an unprecedented opportunity to recognize and advance this relationship. The Fawn River IPA Ecological Atlas is, we hope, the beginning of a process to expand and support Indigenous perspectives on keeping the land while making room (and moving over) (Latulippe & Klenk 2020) for First Nations as part of reconciliation and action in conservation science (Wong et al. 2020).

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2. SUMMARY OF RECOMMENDATIONS

- Research and monitoring projects begin with the free, prior and informed consent of Kitchenuhmaykoosib Inninuwug and other First Nations and should be co-created.
- Establish protocols and best practices to support the use of Indigenous Knowledge Systems and science to provide the best available knowledge to consider the past, current and future conditions of animals and their relationships to terrestrial and freshwater ecosystems.
- Given the cumulative effects of land use and climate change, further research and monitoring led by the community should be explicitly included in planning and decision making about the biodiversity, ecosystems, and ecosystem services that make up the Fawn River IPA.
- The Governments of Ontario and Canada need to recognize the inherent rights, together with Treaty and Aboriginal rights, of Indigenous Peoples and communities as the basis for jurisdiction and decision making in the Fawn River IPA and KIWDA.
- Adequate funding and support to Kitchenuhmaykoosib Inninuwug is required to support community-based research, management and monitoring in the Fawn River IPA.

Freshwater Ecosystems and Fisheries

- Implement a community-based monitoring program, led by KI, to establish the current status of the fish and freshwater systems of the Fawn River IPA and surrounding watershed. This program would provide baseline information and information about trends if the freshwater systems start to change, especially as climate change, development and upstream activities proceed. A community-based monitoring (CBM) program should include species that have both ecological and cultural values and are important for the community. Scientific indicators could include assessments of fish species and abundance; benthic invertebrate species and abundance; water quality and quantity; and contaminant levels in the water and fish.

Terrestrial Ecosystems

- Consider the Fawn River IPA more carefully in decisions about commercial forestry given limited productivity and short growing seasons as well as multiple social and ecological values besides timber and employment.
- Designate eskers as ecologically sensitive and include detailed investigations of any wildlife use associated with eskers in the Fawn River IPA and KIWDA as part of a community-based monitoring program.
- Establish a baseline of terrestrial information, including measuring weather and climate variables, to determine what is changing and how these changes may affect the Fawn River IPA.

Peatland Ecosystems

- Protect the peatlands as a part of the Hudson Bay Lowland, a globally significant source of carbon, critical to provincial and national commitments to reducing carbon emissions.
- Recognize and elevate Kitchenuhmaykoosib Inninuwug's jurisdiction and approach to protection within the Fawn River IPA and KIWDA.
- Conduct baseline and specific research studies with Fawn River IPA staff and KI community on permafrost peatlands within the Fawn River IPA to determine potential for permafrost thaw and changes to land cover, including with the introduction of new land uses such as mineral exploration, mining, roads and other infrastructure.

Birds

- Co-create and compile new knowledge about birds in the Fawn River IPA by developing community-based research and monitoring programs with academic, NGO and/or government scientists and participating in citizen science and community science initiatives such as Ontario's Breeding Bird Atlas.
- Improve bird monitoring in the Fawn River IPA, particularly for culturally and ecologically important species such as waterfowl and shorebirds as well as establish a harvest survey with Fawn River IPA staff and community members.
- Identify, monitor, and map nesting and mating areas for birds in the Fawn River IPA and surrounding region.
- Determine whether and how to engage with the IBA and KBA programs to obtain additional support and national and international recognition of the Fawn River IPA.
- Prioritize designated species at risk in order to obtain funding to support community-based monitoring and research in the Fawn River IPA.

- Address threats to birds in the Fawn River IPA by co-creating indicators as part of community-based monitoring and research programs.
- Increase awareness and understanding of cumulative effects in the Fawn River IPA including climate change by working with Fawn River IPA staff and the community to develop a vision for the future of birds and people in the Fawn River IPA.
- Pursue formal recognition, by Ontario and Canada, for KI's jurisdiction and responsibilities under Kanawayandan D'aaki for the land, water, and birds within the Fawn River IPA in the face of dramatic changes anticipated due to climate change and land use.
- Develop capacity for Fawn River IPA staff to respond to proposals that affect birds and the Fawn River IPA.

Mammals

- Develop a community-based monitoring program in the Fawn River and KIWDA, including human-wildlife conflicts, threats and harvest to support the understanding of the status and trends of mammals.
- Establish limits on road density, water crossings and wetland incursion to minimize risks to mammals and ecosystems that depend upon them.
- Demonstrate the importance of Indigenous-led conservation and IPAs to mammal conservation in northern Ontario.
- Monitor land use within the Fawn River IPA to ensure impacts to caribou do not increase at the range scale.
- Co-create a moose research project with Fawn River IPA staff and community members to address the lack of scientific information on moose population dynamics, distribution and relationships to First Nations in the Fawn River IPA and KIWDA.
- Conduct research with Fawn River IPA staff to better understand habitat use and identify timing and spatial needs for protection of active wolf and/or wolverine dens as well as rendezvous sites in the Fawn River IPA and KIWDA.
- Conduct a baseline survey with Fawn River IPA staff to better understand how beavers are maintaining the terrestrial and riparian habitats in the IPA.
- Work with Fawn River IPA staff to compile and review historical and current trapping information available for beaver to develop a basic understanding of human impacts on beaver populations and possible implications for other mammals like wolves and wolverine.
- Conduct interviews with Elders and Knowledge holders to understand the past and present changes within the Fawn River IPA because of beaver activity and use.

(Credit: Susan Morse)

- Monitor riparian areas in the Fawn River IPA for bat presence and activity and request occupancy probability maps from Ontario to support co-design of bat research and monitoring in the Fawn River IPA.
- Complete an ecosystem services assessment in the Fawn River IPA and KIWDA to identify relevant ecosystem services and highlight the importance of the Fawn River IPA in conserving these services.
- Collect samples from hunter-killed mammals to determine current levels of contaminants in mammals in the Fawn River IPA and KIWDA.
- Establish protocols and best practices to support the use of Indigenous Knowledge Systems and science to provide the best available knowledge to consider the past, current and future conditions of mammals and terrestrial ecosystems.

3. FISH AND FRESHWATER ECOSYSTEMS OF THE FAWN RIVER INDIGENOUS PROTECTED AREA

Prepared by Constance O'Connor, Wildlife Conservation Society Canada

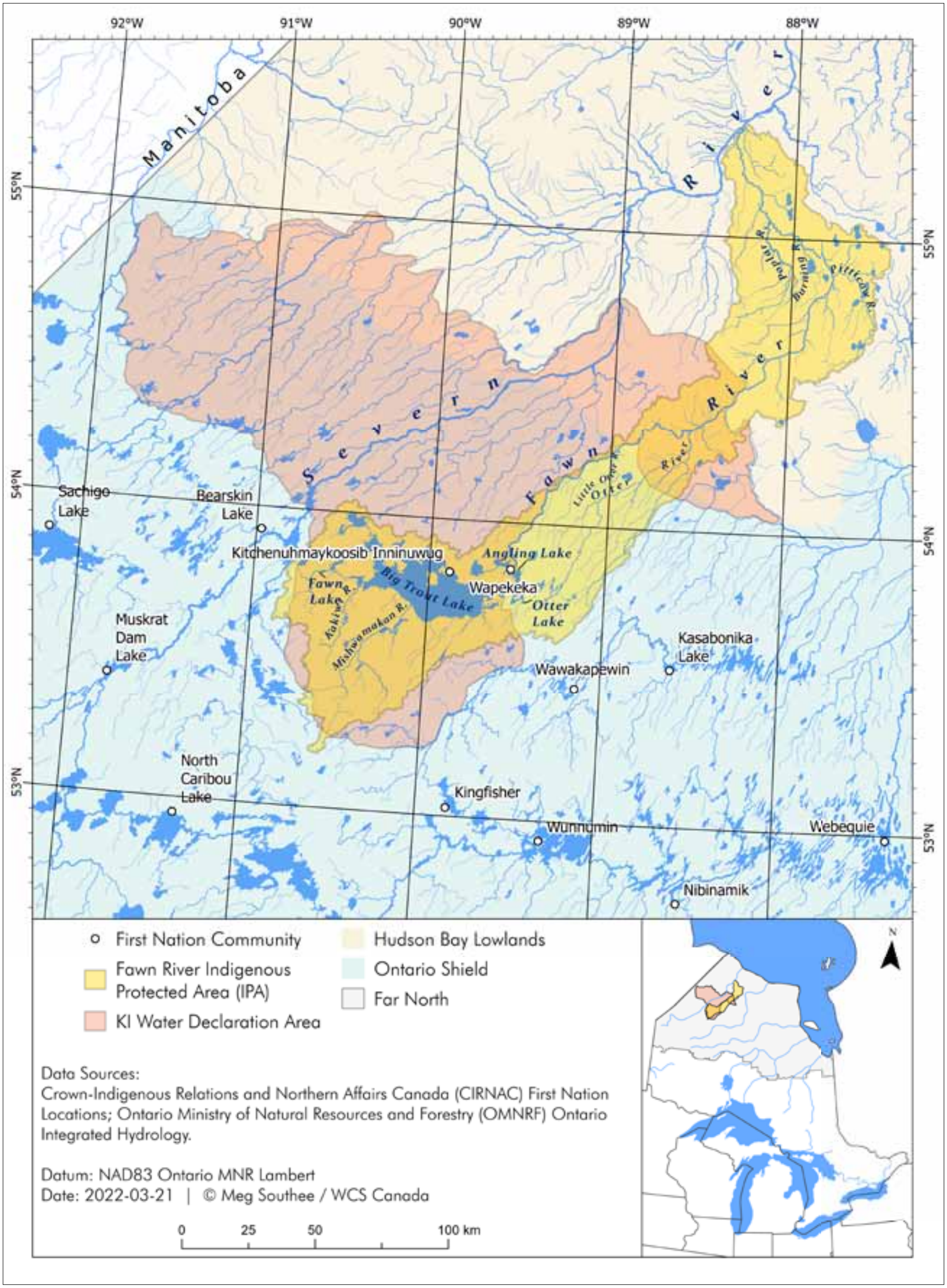
1. Aquatic ecosystems of the Fawn River IPA

The Fawn River Indigenous Protected Area (IPA) encompasses over 13,000 km^2 of intact forests, lakes, streams, rivers and wetlands (Figure 1). The waters and lands have provided for Kitchenuhmaykoosib Inninuwug (the people of Big Trout Lake), or KI, since time beyond memory. They remain the foundation for the Nation in terms of jurisdiction, rights, responsibilities and stewardship for keeping the land and waters for both current and future generations (Ariss & Cutfeet 2012).

The headwaters of the Fawn River watershed start in the forests of the Ontario Shield Ecozone (Rankin et al. 2011) in northwestern Ontario, with small streams that flow northeast into Kitchenuhmaykoosib (Big Trout Lake). At 661 km^2, Kitchenuhmaykoosib is one of the largest lakes in Ontario. With a maximum depth of 40 m, Kitchenuhmaykoosib is also one of the deepest lakes in this region. From Kitchenuhmaykoosib, the Fawn River flows northeast into Angling Lake further northeast for almost 100 km through the Precambrian bedrock and coniferous forest of the Boreal Shield, with black spruce dominating the forest, along with some white spruce, balsam fir and trembling aspen (Rankin et al. 2011). There are some sections with small waterfalls and the river width varies from about 35 m to almost 135 m

(Credit: Allan Lissner)

Figure 1. The rivers and lakes of the Fawn River watershed and the Kitchenuhmaykoosib Inninuwug Water Declaration Area.



Lake trout, the "big trout" that is the namesake of Kitchenuhmaykoosib. (Credit: Paul Vecsei)

when it spreads over flatter landscape. After the Little Otter River joins with the Fawn River, the Fawn River drops down from the Precambrian bedrock of the Ontario Shield onto the sedimentary limestone and marine clay of the Hudson Bay Lowlandss Ecozone (Rankin et al. 2011). Here the landscape is dominated by wetlands and shrubs, moss and lichen are common, with open stands of stunted black spruce, tamarack and white spruce (Rankin et al. 2011). The Fawn River carves a path into the softer substrate and continues for almost another 100 km northeast, meandering slowly through the flat peatlands of the Hudson Bay Lowlandss (HBL), with the Otter River flowing into it in this section. As the Fawn River flows to its furthest eastern extent, the Pitticow River flows into the Fawn River, and this tributary can be used to cross into the Winisk River watershed to the east. After this confluence, the Fawn River makes a wide curve northwest, and continues across the HBL for the rest of its length, with the Burning River and Poplar River flowing into it, before the Fawn River finally flows into the Severn River, approximately 100 km south of Hudson Bay (Figure 1). At almost 300 km, the Fawn River is one of the longest tributaries of the Severn River, which is in turn one of the longest free-flowing rivers remaining in Canada. Globally, only 23% of very long rivers, such as the Severn River, remain free flowing (Grill et al. 2019).

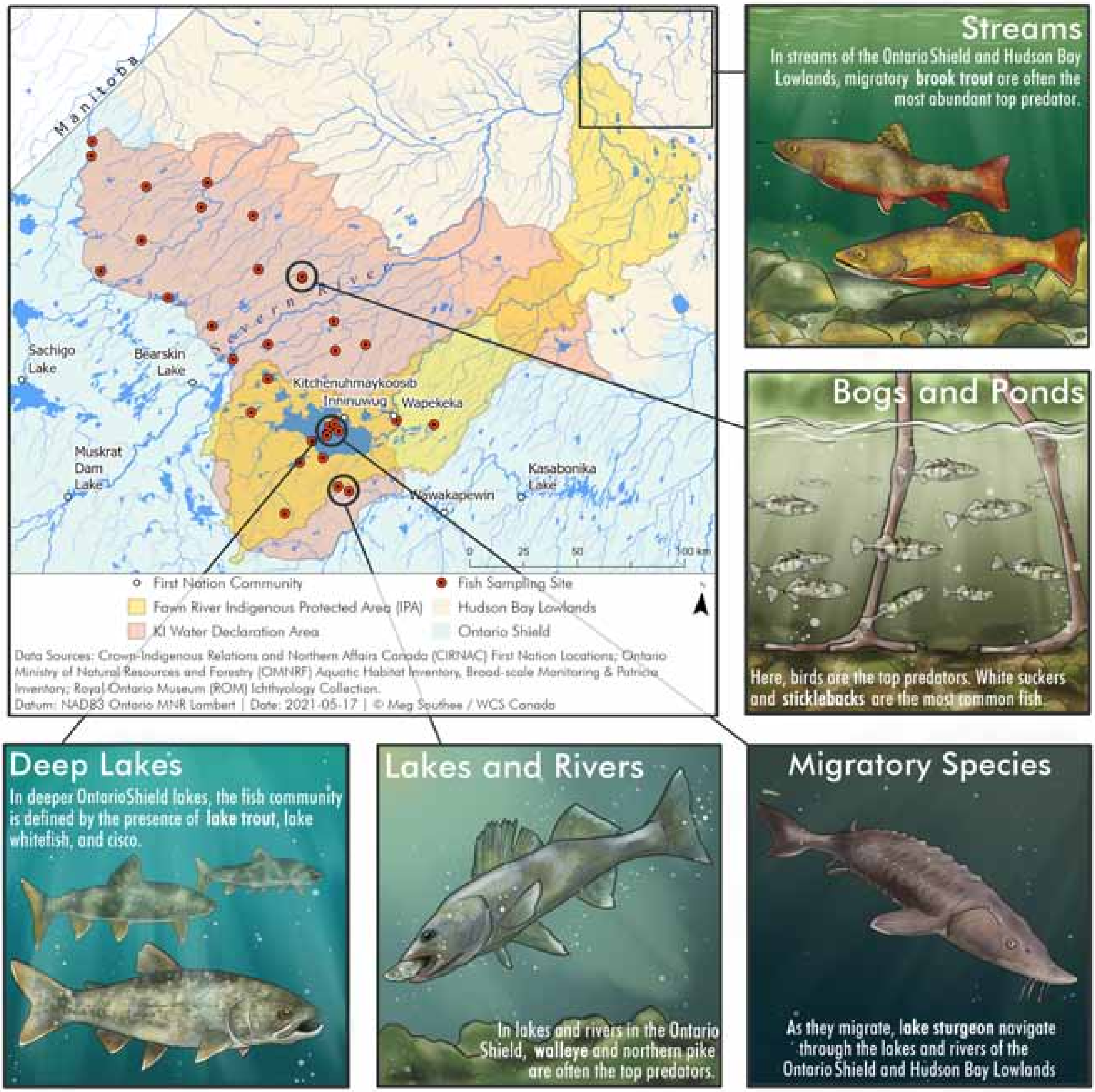
Scientific fish sampling of the Fawn River watershed has been rare and has only occurred in the headwaters, particularly around Kitchenuhmaykoosib. Various scientific sampling efforts since the 1930s have documented at least 30 species.

2. Fish biodiversity of the Fawn River IPA

As the Fawn River flows north, the land transitions from the forests of the Ontario Shield to the wetlands and peatlands of the Hudson Bay Lowlands (Rankin et al. 2011). Globally, transition zones tend to support higher levels of biodiversity relative to other areas (Araújo & Williams 2001, Araújo 2002) and the transition zone between the Ontario Shield and Hudson Bay Lowlands Ecozones is a particularly important area for supporting a diversity of aquatic life (McGovern & Vukelich 2009, FNSAP 2010). Overall, the northern landscapes in Ontario provide habitats for the highest freshwater fish biodiversity with low human impacts in Canada (Chu et al. 2003, 2015). There are 213 fish species in Canada that use fresh water for all or part of their life cycle (Coker et al. 2001) and 53 of these species are broadly recognized to occur in the far northern regions of the Arctic drainage basin in Ontario (Browne 2007, McGovern & Vukelich 2009, FNSAP 2010, Marshall & Jones 2011).

Not surprisingly given the importance of northern Ontario for fresh water, the whole of the Fawn River watershed supports abundant aquatic life. Scientific fish sampling of the Fawn River watershed, however, has been rare and has only occurred in the headwaters, particularly around Kitchenuhmaykoosib. Various scientific sampling efforts since the 1930s (Figure 2) have documented at least 30 species (Appendix 1). Although it has not been documented through the sci-

Figure 2. Scientific fish sampling sites and representative fish communities of the Fawn River watershed and the Kitchenuhmaykoosib Inninuwug Water Declaration Area. (Credit: Lucy Poley)



entific sampling efforts, at least one additional species (brook trout, also known locally as speckled trout) has been commonly reported by community members (KI Cultural Atlas 2015). Because there is such sparse scientific sampling, it is very likely that there are many more species in the Fawn River watershed and Kitchenuhmaykoosib Inninuwug Water Declaration Area (KIWDA) than are currently reported by scientists.

From the scientific sampling records that are available, the fish community in Kitchenuhmaykoosib appear to be representative of a deep, healthy Boreal Shield lake (Browne 2007), with lake trout, lake whitefish and cisco being abundant (Appendix 1, Figure 2).

Top: Orion McKay fishing on the Fawn River. (Credit: Allan Lissner) Bottom: Kitchenuhmaykoosib has been sampled repeatedly by scientists, and lake whitefish and cisco are abundant. (Credit: Paul Vecsei)

The fish communities in the smaller lakes and rivers within the southern portion of the Fawn River watershed are more representative of smaller, shallower, healthy Ontario Shield lake and river communities (Browne 2007), with walleye (also known as pickerel) and northern pike (also known as jackfish) being the top predators (Appendix 1, Figure 2). In the smaller streams of the Fawn River watershed, the fish communities are mainly comprised of small minnows and sticklebacks (Appendix 1). Sticklebacks and suckers are also common in bogs and ponds of the Hudson Bay Lowlands (Browne 2007). While these habitats have not been scientifically sampled in the Fawn River watershed, these characteristic communities have been found through scientific sampling in the bogs and ponds of other areas of the KIWDA adjacent to the Fawn River watershed (Appendix 1, Figure 2). Community reports also show that suckers are commonly harvested within the Fawn River watershed (KI Cultural Atlas 2015).

While the lower Fawn River has never been scientifically sampled, there have been informal reports of brook trout near the confluence with the Severn River, where the brook trout are likely anadromous from Hudson Bay (Browne 2007), and community members frequently report catching brook trout in tributaries of the Otter River as well as in other tributaries of the Fawn River (KI Cultural Atlas 2015). There are also records of lake sturgeon in Kitchenuhmaykoosib (Appendix 1, Figure 2) and in other parts of the Fawn River watershed and KIWDA (KI Cultural Atlas 2015). Lake sturgeon in the Fawn River IPA are part of the Southern Hudson Bay - James Bay population and are are listed as Special Concern by both Canada and Ontario under species at risk legislation (Golder Associates Ltd. 2011).

It is significant that no invasive aquatic species have yet been documented in the Fawn River watershed (Appendix 1). However, there may eventually be rainbow smelt that appear in the watershed since these are now found in the Hudson Bay and may move in through Hudson Bay from the Nelson River to the west (Franzin et al. 1994).

In summary, the Fawn River watershed currently supports diverse native fish populations and there are likely more species in the watershed than those currently documented through the limited scientific sampling efforts that have taken place.

3. Benefits to people provided by the Fawn River IPA fish and freshwater ecosystems

The fresh waters of the Fawn River watershed – the lakes, rivers, streams, ponds, and wetlands – provide benefits for Kitchenuhmaykoosib Inninuwug, and for people beyond the community.

At the local level, wetlands and smaller streams and ponds with lots of vegetation provide natural flood control, water filtration and erosion prevention. The larger rivers and waterways regulate the local climate through evaporation and provide natural fire breaks and refuges for wildlife during forest fires (Grizzetti et al. 2015).

At the height of the commercial fishery, there was a quota of 34,000 kg of lake trout from Kitchenuhmaykoosib in 1964.

Freshwater ecosystems also play an important role in cycling nutrients in the landscape. Leaves, vegetation and other natural materials tend to accumulate in water and decompose and then the movement of the water transports these nutrients to different areas (Grizzetti et al. 2015). Fish can also play an important role in cycling nutrients. For example, the spawning migrations of suckers play an important role in bringing nutrients back into small streams that are important to support healthy populations of insects and birds (Childress et al. 2014).

The water of Kitchenuhmaykoosib is still fresh and clean and Kitchenuhmaykoosib Inninuwug rely on this water as drinking water for the community. Many people report that the water is so clean and fresh that they still drink directly from the lake.

Rivers and waterways are also vital for transportation for Kitchenuhmaykoosib Inninuwug, allowing people to travel by boat in the summer and by snowmobile on the frozen surfaces in the winter, to reach fishing grounds, hunting areas and areas that are culturally and spiritually important within the homeland (KI Cultural Atlas 2015).

Walleye (also locally known as pickerel) was historically targeted by commercial fisheries and is now a popular catch by community members. (Credit: Eric Engbretson)

All of the freshwater ecosystems, from the smaller streams up to the large lakes, are essential as habitat and as a source of water for the plants and wildlife of the Fawn River watershed, which in turn provide sustenance for Kitchenuhmaykoosib Inninuwug.

The fish of the Fawn River watershed have provided food, sustenance and cultural values for Kitchenuhmaykoosib Inninuwug since time immemorial. From the KI Cultural Atlas (2015) community members still report frequent catches of lake trout, walleye, northern pike, sucker, brook trout and lake whitefish.

Fish are so abundant through the Fawn River watershed and the KIWDA that they have also historically attracted commercial fisheries. Through the middle of the twentieth century, there were commercial fisheries for lake trout, walleye and lake whitefish, although the most prized target was lake trout. At the height of the commercial fishery, there was a quota of 34,000 kg of lake trout from Kitchenuhmaykoosib in 1964 (see the associated Appendices and Marshall & Jones 2011). However, concerns over mercury levels in fish (see section 4) and decreasing profit margins closed these fisheries by the 1970s (see the associated Appendices and Marshall & Jones 2011). Currently, there are inactive licences for Kitchenuhmaykoosib, Fawn Lake and Fawn River.

At the global scale, fresh water is increasingly being recognized as an important component of the global carbon cycle, which is important to regulating the climate (Cole et al. 2007, Tranvik et al. 2018). As leaves, vegetation and other materials fall into waters and decompose, this decomposition releases carbon gases into the atmosphere. However, the waterlogged conditions of rivers and lakes can also slow decomposition and lock carbon away in the sediments. This role of locking carbon away in the sediments plays an important role in reducing atmospheric gases and fighting climate change (Cole et al. 2007, Tranvik et al. 2018). Therefore, freshwater ecosystems such as the lakes and rivers of the Fawn River watershed have a vital role in regulating global climate and benefiting people around the world, as well as providing immeasurable benefits to Kitchenuhmaykoosib Inninuwug who live within the watershed.

There have already been reports of fish kills of white sucker in the Hudson Bay Lowlands when summer temperatures are unusually hot. (Credit: Eric Engbretson)

4. Threats

Climate change

Historically, the Fawn River watershed has experienced cool summers, cold winters and moderate levels of precipitation. In the southern portions of the Fawn River watershed that are within the Ontario Shield Ecozone, historical mean summer temperature is 12.5°C, while mean winter temperature is -17°C (ESWG 1995). In the north, in the Hudson Bay Lowlands Ecozone, summer temperature is 11°C, while mean winter temperature is -18.5°C (ESWG 1995). However, trend analysis indicates that mean summer air temperatures have already risen by almost 2°C in the area of the Fawn River watershed (Abraham et al. 2011). Overall, the region is predicted to experience some of the biggest temperature increases in Ontario (Colombo et al. 2007).

For the Fawn River watershed, these warmer temperatures mean that aquatic invasive species, if introduced, may be able to move further north as temperatures become more hospitable to them (Dove-Thompson et al. 2011). Conversely, native cool- and cold-water fish species, such as lake trout, are likely to have reduced habitat as the cooler areas that they rely on become less common (Dove-Thompson et al. 2011). There is also likely to be an increase in summer fish kills of native cool- and cold-water species with higher summer temperatures. Indeed, there have already been reports of summer fish kills of brook trout and white sucker in the Sutton River, to the northeast of the Fawn River watershed (Gunn & Snucins 2010). Other effects of warmer temperatures may include increased fish diseases and parasites and increased algae blooms (Dove-Thompson et al. 2011).

In the Fawn River watershed, mean annual precipitation ranges from approximately 500 mm to 700 mm, with the highest precipitation in the southeast and the lowest precipitation in the northwest (ESWG 1995). However, climate change modelling predictions suggest that there will be decreases in both summer and winter precipitation for this area (Colombo et al. 2007). Combined with postglacial rebound – the land rising after the heavy ice sheets of the last Ice Age retreated – that is occurring in the HBL (Abraham et al. 2011) this means that the Fawn River watershed is expected to become drier in the future.

There is likely to be a drying of wetlands, with a succession in vegetation in the wettest areas from mosses and lichens to shrubs, and then to forests. Some small streams will likely dry up and river depth will decrease (Dove-Thompson et al. 2011). Some previously navigable areas may become too shallow for boats and fish, causing a reduction and change in fish habitat and also changes in how people are able to access and use the river for travel, hunting and fishing. There will also likely be an increase in forest fires with this warmer and drier land and climate (Wotten et al. 2005).

Trend analysis indicates that mean summer air temperatures have already risen by almost 2°C in the area of the Fawn River watershed. Overall, the region is predicted to experience some of the biggest temperature increases in Ontario.

Current and future land use

In terms of development, there are currently approximately 60 km of winter roads within the headwaters of the Fawn River watershed, which are the northernmost sections of the winter roads connecting Kitchenuhmaykoosib Aaki and Wapekeka to the Ontario all-season road at Pickle Lake. There are also plans to install approximately 50 km of transmission lines in this area over the next few years, through the Wataynikaneyap Power project. These transmission lines will connect Kitchenuhmaykoosib Aaki and Wapekeka to the Ontario electrical grid and provide more sustainable options for energy use in the community, who now rely on diesel to generate electricity and heat homes. However, there are also some ecological risks to these developments. Melting permafrost due to a warming climate, combined with clearing land for winter roads and transmission lines, can cause slumping and erosion at water crossings and can increase sedimentation or change the water flow in these headwaters.

The outlet of Kitchenuhmaykoosib has been identified as a potential hydropower development (Hatch 2013). Hydropower development can impact streams, rivers and lakes, including: destruction of habitat for fish and other aquatic animals; blocking the movement of fish and other aquatic animals; changing water flow patterns; and increasing methylmercury and greenhouse gas emissions due to upstream flooded areas (Rosenberg et al. 1997).

Interactive and cumulative effects

Melting permafrost and a shorter winter road season as a result of the warming climate also means more pressure for all-season roads to provide more reliable year-round access to communities. All-season roads can have a multitude of impacts on the streams, rivers and lakes including: destruction of habitat for fish and other aquatic animals; blocking the movement of fish and other aquatic animals; changing water flow patterns; increasing chemical runoff; increasing fishing pressure; increasing the risk of people bringing in invasive species, particularly baitfish or sportfish as recreational and sport fishing pressure increases; and paving the way for further mineral exploration and industrial developments, such as mining, when regions become more accessible (Trombulak & Frissell 2000).

In summary, the Fawn River watershed is expected to become warmer and drier in the future, which could change the habitats for aquatic species and change how people are able to use and protect the river. In the face of a changing climate and the impacts on aquatic ecosystems, minimizing additional industrial developments will reduce the overall cumulative impacts in the watershed.

Contaminants

Information about contaminants in fish from the Fawn River watershed is limited, with only a few species and locations sampled. The Ontario Ministry of the Environment, Conservation and Parks (MECP) regularly samples fish for contaminants throughout Ontario and routinely produces the *Guide to Eating Fish*, most recently in 2020.

Contaminant testing shows that the smaller individuals of many fish species, including northern pike, can be eaten safely many times each month. (Credit: Paul Vecsei)

Within the Fawn River watershed, fish from Kitchenuhmaykoosib, Angling Lake and Fawn Lake were all sampled most recently by MECP for contaminants in 2015. In Kitchenuhmaykoosib, MECP sampled burbot, lake trout, lake whitefish, longnose sucker, northern pike, walleye and white sucker. In Fawn Lake, only walleye was sampled. In Angling Lake, only northern pike was sampled (Appendix 2).

Although the data are limited, the MECP guidelines state that many of the fish from the waterbodies of the Fawn River watershed are healthy and safe for people to eat frequently. In particular, the smaller individuals of many species are safe to eat many times each month, including it being safe to eat a daily meal of smaller burbot, longnose sucker, northern pike, walleye and white sucker (Appendix 2).

While many of the smaller fish from the Fawn River watershed are healthy and safe to eat, there are still some restrictions. Larger fish of all species (with the exception of lake whitefish) have sufficient levels of mercury in their bodies to warrant consumption restrictions (Appendix 2). Mercury is a toxic element that is accumulated by fish, wildlife and humans (Driscoll et al. 2013). Many industrial activities, including burning coal, the mining and smelting of some metals, hydropower development and forestry activities, can all increase the toxic, biologically available form of mercury in the surrounding environment (Selin 2009). Mercury is also a global pollutant and can travel very long distances from sources of industrial contamination (Driscoll et al. 2013). The peat-rich soils of northern Ontario, and especially the Hudson Bay Lowlands Ecozone, make this region vulnerable to mercury contamination because mercury binds readily to the peatland vegetation and soil and then becomes available for uptake by the animals living in the area. As a result, mercury levels are assumed to be high in many parts of northern Ontario (Miller et al.

2005, Brazeau et al. 2013). Indeed, concerns about mercury in the Fawn River watershed have been raised as early as the 1970s, when commercially caught fish in Kitchenuhmaykoosib had sufficiently high mercury that each shipment of fish had to be detained and tested to determine the mercury concentration and whether the fish could be sold; mixed with lower mercury fish and then sold; or had to be discarded (Carlson 1979).

In addition to the restrictions for eating large fish because of mercury, lake trout of all sizes from Kitchenuhmaykoosib have sufficient polychlorinated biphenyls (PCBs) to warrant MECP consumption advisories (Appendix 2). Polychlorinated biphenyls were historically used for a wide variety of industrial activities, particularly for transformers and electrical capacitors, as well as being used as additives for paint and other uses (Carpenter 2006). Although the manufacture of PCBs has been banned in North America since the mid-1970s, they are extremely persistent in the environment (Carpenter 2006). In water sampling reports, there were also elevated levels of mercury and PCBs reported in water samples from Kitchenuhmaykoosib (OCWA 2001).

Finally, lake whitefish in Big Trout Lake have sufficient levels of dioxins and furans to warrant consumption advisories (Appendix 2). Dioxins and furans are toxic chemicals that are also very persistent in the environment and are produced as byproducts from combustion, including during the synthesis and combustion of pesticides, burning waste, burning fossil fuels, forest fires and pulp and paper mills (Kanan & Samara 2018).

Overall, the limited information that is available on contaminants in fish from waterbodies in the Fawn River watershed suggests that many fish from this area are healthy and safe to eat frequently, particularly the smaller individuals of many species, including burbot, longnose sucker, northern pike, walleye and white sucker (Appendix 2). However, there are some concerns from global pollutants like mercury for larger fish of these species, as well as PCBs for lake trout, and dioxins and furans for lake whitefish (Appendix 2).

There are some concerns from global pollutants like mercury for larger fish of these species, as well as PCBs for lake trout, and dioxins and furans for lake whitefish.

5. Headwaters and tributaries of the Fawn River watershed are a priority for protection for freshwater fish

WCS Canada recently completed as assessment of which watersheds in northern Ontario warrant more attention for research, monitoring and protection, given the overall freshwater fish biodiversity in the region (Southee et al. 2021). We looked at the Arctic drainage basin in Ontario, which is the area of Ontario where all of the water flows north, to Hudson and James Bays. Using the available scientific data on fish, we first built species distribution models for the 30 most common native species of the Arctic watershed, which gave us a measure of where species are found within the area. We also collected information on all existing developments in the landscape. We then used computer algorithms to select the watersheds that have the highest freshwater fish biodiversity, while avoiding existing impacts (Southee et al. 2021). The algorithm also maximized the connectivity of watersheds, which means that larger connected areas were preferred by the algorithm over smaller isolated areas (Southee et al. 2021).

For this assessment, we used targets of 17% and 30% of the overall Arctic drainage basin in Ontario. This means that we set up the computer algorithm

Large parts of the Fawn River watershed, particularly the Kakiwi River, the Mishwamakan River and surrounding tributaries, tributaries of the Otter River following in from the river right (i.e., from the right side of the river when looking downstream), the Pitticow River, the Poplar River, and tributaries near the confluence with the Severn River flowing in from the river right, are all identified as important for lake sturgeon in the Arctic drainage basin in Ontario. (Credit: Eric Engbretson)

to first select the top watersheds within 17% of the Arctic drainage basin area, and then to additionally select the watersheds within 30% of the overall Arctic drainage basin area. We considered the watersheds selected within the 17% scenario to be the highest priority for freshwater fish biodiversity. We considered the additional areas that were selected at the 30% scenario, but not the 17% scenario, as the high priority areas.

From this assessment, protecting the headwaters and many of the tributaries of the Fawn River watershed were identified as a priority for protecting the freshwater fish biodiversity of northern Ontario overall (Figure 3). Specifically, the Kakiwi River, the Mishwamakan River and surrounding tributaries, the Pitticow River, and tributaries flowing into the Otter River from the river right (in other words, the tributaries flowing into the Otter River from the right side when looking downstream) were all selected among the highest priority for protecting freshwater fish biodiversity in the Arctic drainage basin in Ontario (Figure 3).

When looking at the Kitchenuhmaykoosib Inninuwug homeland outside of the Fawn River watershed, almost all of the tributaries of the Severn River within the larger area were also identified as being the highest or high priority for protecting freshwater fish biodiversity in the Arctic watershed in Ontario (Figure 3).

This assessment also looked at which watersheds in the Arctic drainage basin in Ontario are a priority for protecting four species of interest: lake sturgeon, lake whitefish, walleye and brook trout (Southee et al. 2021). As with our assessment for overall biodiversity, these assessments used targets of selecting 17% of the area (selecting the highest priority watersheds) and then selecting 30% of the area (selecting high priority watersheds). We again used computer algorithms to maximize the representation of these fish species and connectivity of watersheds, while avoiding existing impacts (Southee et al. 2021).

We found that the Fawn River watershed is even more important when looking specifically at lake sturgeon, lake whitefish and walleye. All of the Otter River watershed, as well as all of the Fawn River watershed below the confluence with the Otter River, were identified as a high or highest priority for the protection for these species (Figure 4). The Poplar River and tributaries flowing into the Fawn River near the confluence with the Severn River from the river right were also selected as the highest priority for protecting lake sturgeon (Figure 4).

As noted in section 2 above, the headwaters of the Fawn River watershed are not generally known for supporting brook trout. However, lower tributaries, including both the Pitticow River and Poplar River, were identified as a high priority for protecting brook trout in northern Ontario (Figure 4).

Figure 3. WCS Canada recently completed an assessment of which watersheds in the Arctic drainage basin in Ontario are the priority for protecting freshwater fish biodiversity. We used computer algorithms to select the top watersheds that maximize freshwater fish biodiversity and connectivity and minimize existing human impacts. In this assessment, we found that the headwaters of the Fawn River, the Pitticow River and tributaries of the Otter River flowing in from the river right (i.e., flowing into the Otter River from the right side of the river when looking downstream) were all selected as the highest priority for protecting freshwater fish biodiversity in the Arctic drainage basin in Ontario. Almost all of tributaries of the Severn River within the larger Kitchenuhmaykoosib Inninuwug Water Declaration Area were also identified as being the highest or high priority for protecting freshwater fish biodiversity in the Arctic watershed in Ontario.

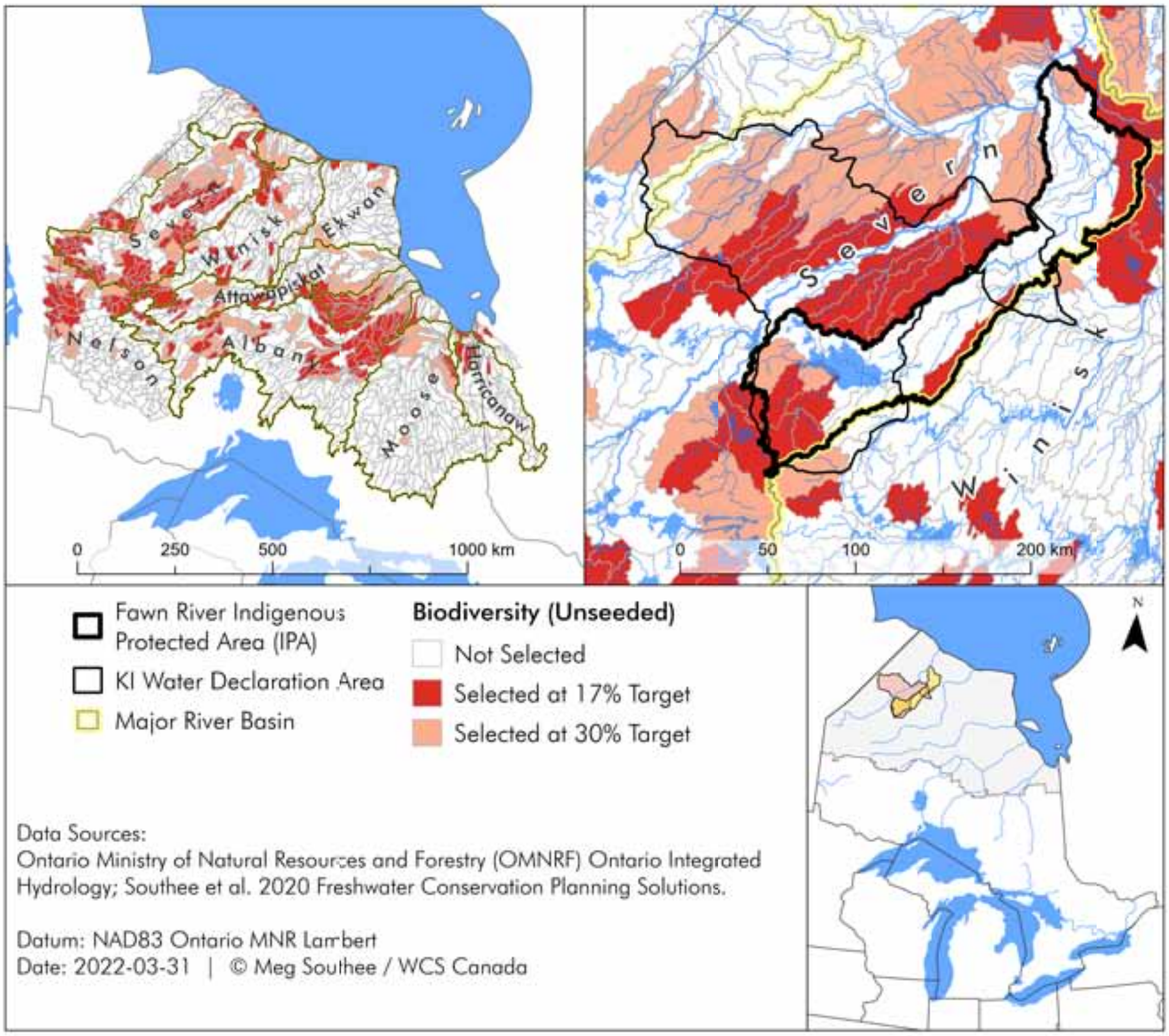
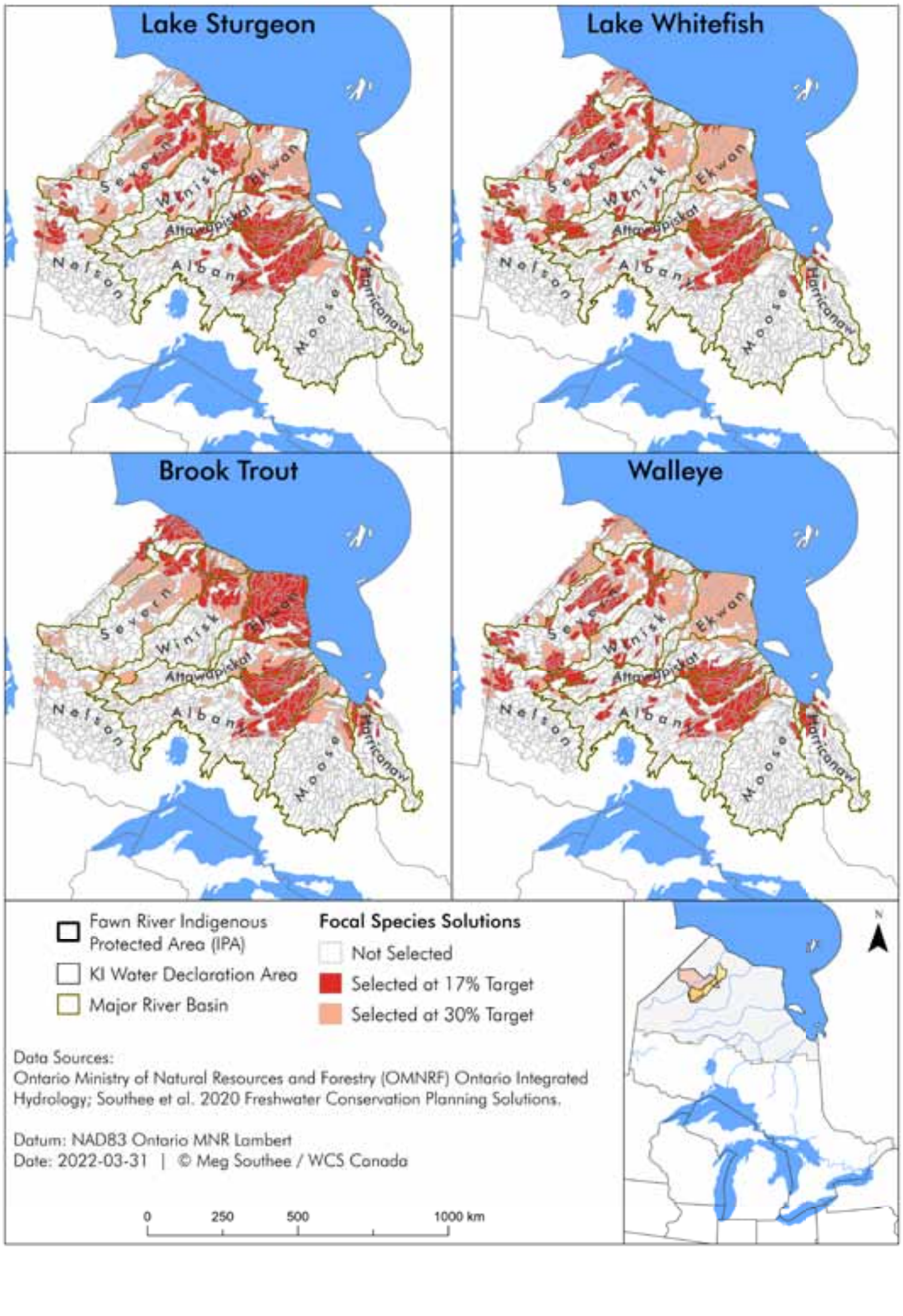


Figure 4. WCS Canada recently completed an assessment of which watersheds in the Arctic drainage basin in Ontario are the priority for protecting four species of interest: lake sturgeon, lake whitefish, brook trout and walleye. We used computer algorithms to select the top watersheds that maximize the representation of each of these species, minimize existing human impacts and maximize connectivity of priority areas. For lake sturgeon, lake whitefish and walleye, we found that all of the Otter River watershed, as well as all of the Fawn River watershed below the confluence with the Otter River, were identified as a high or highest priority for the protection for these species. The Poplar River and tributaries flowing in to the Fawn River near the confluence with the Severn River from river right (i.e., the right side of the river when looking downstream) were also selected as the highest priority for protecting lake sturgeon. Both the Pitticow River and Poplar River were identified as a high priority for protecting brook trout. Almost all of tributaries of the Severn River within the larger Kitchenuhmaykoosib Inninuwug Water Declaration Area were also identified as being the highest or high priority for protecting these four species in the Arctic watershed in Ontario.



When looking at the Kitchenuhmaykoosib Inninuwug homeland outside of the Fawn River watershed, almost all of the tributaries of the Severn River within the larger area were also identified as being the highest or high priority for protecting these four species of interest in the Arctic drainage basin in Ontario (Figure 4).

There are 30 species of freshwater fish that have been documented by scientific sampling in the Fawn River watershed. However, with sparse scientific sampling, it is likely that there are more species than currently reported by scientists. For example, brook trout (also known as speckled trout) has not been documented through scientific sampling efforts, but is frequently reported by community members. (Credit: Sean Landsman)

6. Recommendations

Overall, there are a lack of scientific data on the fish and fresh water of the Fawn River watershed, with no scientific sampling farther north than the larger lakes of the headwaters. There are likely species that have not been documented and there is little scientific information on the status or trends of freshwater species or their habitats. However, Kitchenuhmaykoosib Inninuwug have Indigenous and local knowledge of these areas and have been stewards for these systems since time beyond memory (KI Cultural Atlas 2015). As one example, brook trout (also known as speckled trout) has not been documented through scientific sampling efforts, but is frequently reported by community members (KI Cultural Atlas 2015). Kitchenuhmaykoosib Inninuwug hold the knowledge about the fish and freshwater systems and are in the best position to understand the future research and monitoring needs, as well as collect additional traditional and scientific information about the fish and freshwater systems of the Fawn River watershed.

Implementing a community-based monitoring program led by KI would be valuable in establishing the current status of the fish and freshwater systems of the Fawn River watershed.

Implementing a community-based monitoring program led by KI would be valuable in establishing the current status of the fish and freshwater systems of the Fawn River watershed. Such a program would provide baseline information and information about trends if the freshwater systems start to change, especially as climate change, development and upstream activities proceed. A community-based monitoring program could be focused on species and ecological measures that are important to the community. Scientific indicators could also be included, which would be valuable for comparing the Fawn River watershed with other sites and studies. Important scientific indicators could include assessments of fish species and abundance; benthic invertebrate species and abundance; water quality and quantity; and contaminant levels in the water and fish.

From a policy perspective, the Government of Ontario needs to recognize the inherent rights together with Treaty and Aboriginal rights of Indigenous Peoples protected in the Canadian Constitution as the basis for jurisdiction and decision making across the Fawn River watershed. Further, there needs to be adequate funding and support to Kitchenuhmaykoosib Inninuwug to enable community-based research, management and monitoring.

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8. Appendices

Appendix 1. Fish species of the Fawn River watershed and the Kitchenuhmaykoosib Inninuwug homelands

WCS Canada compiled all of the species occurrence records from as many scientific sources as possible, including records from the Royal Ontario Museum (ROM) and from three Ontario Ministry of Natural Resources and Forestry (OMNRF) databases: 1) the Patricia Inventory (PAT), which contains fish occurrence records from government sampling efforts that took place between 1959 and 1964; 2) the Aquatic Habitat Index (AHI) database, which contains fish occurrence records from government sampling efforts that took place between 1970 to 1990; and 3) the Broadscale Monitoring program (BsM) database, which contains fish occurrence records from government sampling efforts that took place between 2008 to 2012.

Table A1.1 provides a list of all of the fish species that have been documented in the Fawn River watershed from these various databases, while Table 2 provides a list of all of the fish species that have been documented in the Kitchenuhmaykoosib Inninuwug traditional homeland, in areas outside of the Fawn River watershed.

Note that there was also one early record of a shortjaw cisco (*Coregonus zenithicus*) in Big Trout Lake (Ryder et al. 1964). However, classification of the *C. artedi* complex was (and continues to be) an issue, and genetic sampling is required for definitive verification (Marshall & Jones 2010). The shortjaw cisco is not included in the current list.

References

Marshall TR, Jones N. 2011. Aquatic Ecosystems of the Far North of Ontario: State of Knowledge. Applied Research and Development Branch, Ontario Ministry of Natural Resources.

Ryder RA, Scott WB, Crossman EJ. 1964. Fishes of northern Ontario, north of the Albany River. Royal Ontario Museum, Life Sciences Contributions 60: 1-30.

Table A1.1. List of fish species in the Fawn River watershed identified through various scientific survey efforts.

Common name	Latin name	Location(s)	Record source(s)
Blacknose shiner	*Notropis heterolepis*	Big Trout Lake	ROM
Brook stickleback	*Culaea inconstans*	Smaller tributaries	AHI
Burbot	*Lota lota*	Big Trout Lake; smaller tributaries	AHI; BsM; PAT; ROM
Cisco	*Coregonus artedi*	Big Trout Lake; smaller tributaries	AHI; BsM; PAT; ROM
Fathead minnow	*Pimephales promelas*	Smaller tributaries	AHI
Finescale dace	*Chrosomus neogaeus*	Smaller tributaries	AHI; ROM
Goldeye	*Hiodon alosoides*	Big Trout Lake	PAT
Iowa darter	*Etheostoma exile*	Fawn River; smaller tributaries	AHI
Johnny darter	*Etheostoma nigrum*	Big Trout Lake; Fawn River; smaller tributaries	AHI; BsM; ROM
Lake chub	*Couesius plumbeus*	Big Trout Lake; smaller tributaries	AHI; BsM; ROM
Lake sturgeon	*Acipenser fulvescens*	Big Trout Lake	PAT
Lake trout	*Salvelinus namaycush*	Big Trout Lake	BsM
Lake whitefish	*Coregonus clupeiformis*	Big Trout Lake; smaller tributaries	AHI; BsM; PAT; ROM
Logperch	*Percina caprodes*	Big Trout Lake; Fawn River; smaller tributaries	AHI; BsM; ROM
Longnose dace	*Rhinichthys cataractae*	Big Trout Lake	ROM
Longnose sucker	*Catostomus catostomus*	Big Trout Lake	BsM; PAT; ROM
Mottled sculpin	*Cottus bairdii*	Big Trout Lake; smaller tributaries	AHI; ROM
Ninespine stickleback	*Pungitius pungitius*	Big Trout Lake; smaller tributaries	AHI; BsM; ROM
Northern pike	*Esox lucius*	Big Trout Lake; Fawn River; smaller tributaries	AHI; BsM; PAT; ROM
Pearl dace	*Margariscus margarita*	Big Trout Lake; smaller tributaries	AHI; ROM
Round whitefish	*Prosopium cylindraceum*	Big Trout Lake	PAT
Sauger	*Sander canadensis*	Big Trout Lake	BsM
Sculpin	*Cottus spp.*	Big Trout Lake	PAT
Shorthead redhorse	*Moxostoma macrolepidotum*	Big Trout Lake	BsM
Slimy sculpin	*Cottus cognatus*	Big Trout Lake; smaller tributaries	AHI; BsM; ROM
Spottail shiner	*Notropis hudsonius*	Big Trout Lake; Fawn River; smaller tributaries	AHI; BsM; ROM
Trout-perch	*Percopsis omiscomaycus*	Big Trout Lake; smaller tributaries	AHI; BsM; ROM
Walleye	*Sander vitreus*	Big Trout Lake; smaller tributaries	AHI; BsM; PAT; ROM
White sucker	*Catostomus commersonii*	Big Trout Lake; Fawn River; smaller tributaries	AHI; BsM; PAT; ROM
Yellow perch	*Perca flavescens*	Big Trout Lake; Fawn River; smaller tributaries	AHI; BsM; PAT; ROM

Table A1.2. List of fish species in the Kitchenuhmaykoosib Inninuwug homelands outside of the Fawn River watershed identified through various scientific survey efforts.

Common name	Latin name	Record source(s)
Brook stickleback	*Culaea inconstans*	AHI
Burbot	*Lota lota*	AHI
Cisco	*Coregonus artedi*	AHI
Emerald shiner	*Notropis atherinoides*	AHI
Fathead minnow	*Pimephales promelas*	AHI; ROM
Iowa darter	*Etheostoma exile*	AHI
Johnny darter	*Etheostoma nigrum*	AHI; BsM
Lake chub	*Couesius plumbeus*	AHI
Lake whitefish	*Coregonus clupeiformis*	AHI
Longnose sucker	*Catostomus catostomus*	AHI
Mottled sculpin	*Cottus bairdii*	AHI
Ninespine stickleback	*Pungitius pungitius*	AHI
Northern pike	*Esox lucius*	AHI
Pearl dace	*Margariscus margarita*	AHI
Sauger	*Sander canadensis*	AHI
Slimy sculpin	*Cottus cognatus*	AHI
Spottail shiner	*Notropis hudsonius*	AHI
Trout-perch	*Percopsis omiscomaycus*	AHI
Walleye	*Sander vitreus*	AHI
White sucker	*Catostomus commersonii*	AHI
Yellow perch	*Perca flavescens*	AHI

Appendix 2. Contaminants in fish from the Fawn River watershed

The Ontario Ministry of the Environment, Conservation and Parks (MECP) regularly samples fish for contaminants throughout Ontario and routinely produces the *Guide to Eating Fish*, most recently in 2020.

Within the Fawn River watershed, fish from Kitchenuhmaykoosib, Angling Lake and Fawn Lake were sampled most recently by MECP for contaminants in 2015. In Kitchenuhmaykoosib, MECP sampled burbot, lake trout, lake whitefish, longnose sucker, northern pike, walleye and white sucker. In Fawn Lake, only walleye was sampled. In Angling Lake, only northern pike was sampled.

Table A2.1 lists the maximum meals per month for each size class of each species sampled, for the sensitive population (children and people who are pregnant, breastfeeding or may become pregnant), and for the general population.

Note that the maximum meals per month are total meals. This means that all species of fish eaten per month must be considered towards the total. For example, someone from the general population could eat 12 lake trout or they could eat 12 lake whitefish. However, if this person wanted to eat both lake trout and lake whitefish, they could only eat 12 fish total of these two species combined.

Table A2.1. The maximum meals per month that can be consumed of fish of various species and sizes from waterbodies of the Fawn River watershed, according to Ontario Ministry of the Environment, Conservation and Parks sampling and guidelines from 2015.

Fish common name	Fish length	Population consuming the fish	Maximum meals per month	Reason for advisory	Specific location
Burbot (Ling)	45-50cm	General	32		Big Trout Lake
Burbot (Ling)	50-55cm	General	16	Mercury	Big Trout Lake
Burbot (Ling)	55-60cm	General	16	Mercury	Big Trout Lake
Burbot (Ling)	60-65cm	General	16	Mercury	Big Trout Lake
Burbot (Ling)	45-50cm	Sensitive	12	Mercury	Big Trout Lake
Burbot (Ling)	50-55cm	Sensitive	8	Mercury	Big Trout Lake
Burbot (Ling)	55-60cm	Sensitive	8	Mercury	Big Trout Lake
Burbot (Ling)	60-65cm	Sensitive	4	Mercury	Big Trout Lake
Lake Trout	30-35cm	General	12	PCB	Big Trout Lake
Lake Trout	35-40cm	General	12	PCB	Big Trout Lake
Lake Trout	40-45cm	General	12	PCB	Big Trout Lake
Lake Trout	45-50cm	General	12	PCB	Big Trout Lake
Lake Trout	50-55cm	General	12	PCB	Big Trout Lake
Lake Trout	55-60cm	General	12	PCB	Big Trout Lake
Lake Trout	60-65cm	General	12	PCB	Big Trout Lake
Lake Trout	65-70cm	General	12	PCB	Big Trout Lake
Lake Trout	30-35cm	Sensitive	12	PCB	Big Trout Lake
Lake Trout	35-40cm	Sensitive	12	PCB	Big Trout Lake
Lake Trout	40-45cm	Sensitive	12	PCB	Big Trout Lake
Lake Trout	45-50cm	Sensitive	12	PCB	Big Trout Lake
Lake Trout	50-55cm	Sensitive	8	Mercury	Big Trout Lake
Lake Trout	55-60cm	Sensitive	8	Mercury	Big Trout Lake
Lake Trout	60-65cm	Sensitive	8	Mercury	Big Trout Lake
Lake Trout	65-70cm	Sensitive	4	Mercury	Big Trout Lake
Lake Whitefish	20-25cm	General	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	25-30cm	General	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	30-35cm	General	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	35-40cm	General	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	40-45cm	General	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	45-50cm	General	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	50-55cm	General	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	55-60cm	General	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	60-65cm	General	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	20-25cm	Sensitive	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	25-30cm	Sensitive	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	30-35cm	Sensitive	12	Dioxins/Furans	Big Trout Lake

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Fish common name	Fish length	Population consuming the fish	Maximum meals per month	Reason for advisory	Specific location
Lake Whitefish	35-40cm	Sensitive	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	40-45cm	Sensitive	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	45-50cm	Sensitive	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	50-55cm	Sensitive	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	55-60cm	Sensitive	12	Dioxins/Furans	Big Trout Lake
Lake Whitefish	60-65cm	Sensitive	12	Dioxins/Furans	Big Trout Lake
Longnose Sucker	35-40cm	General	32		Big Trout Lake
Longnose Sucker	40-45cm	General	32		Big Trout Lake
Longnose Sucker	45-50cm	General	32		Big Trout Lake
Longnose Sucker	35-40cm	Sensitive	32		Big Trout Lake
Longnose Sucker	40-45cm	Sensitive	16	Mercury	Big Trout Lake
Longnose Sucker	45-50cm	Sensitive	12	Mercury	Big Trout Lake
Northern Pike	45-50cm	General	32		Angling Lake
Northern Pike	50-55cm	General	32		Angling Lake
Northern Pike	55-60cm	General	16	Mercury	Angling Lake
Northern Pike	60-65cm	General	16	Mercury	Angling Lake
Northern Pike	45-50cm	Sensitive	16	Mercury	Angling Lake
Northern Pike	50-55cm	Sensitive	12	Mercury	Angling Lake
Northern Pike	55-60cm	Sensitive	8	Mercury	Angling Lake
Northern Pike	60-65cm	Sensitive	8	Mercury	Angling Lake
Northern Pike	>75cm	General	4	Mercury	Big Trout Lake
Northern Pike	35-40cm	General	32		Big Trout Lake
Northern Pike	40-45cm	General	32		Big Trout Lake
Northern Pike	45-50cm	General	32		Big Trout Lake
Northern Pike	50-55cm	General	16	Mercury	Big Trout Lake
Northern Pike	55-60cm	General	16	Mercury	Big Trout Lake
Northern Pike	60-65cm	General	16	Mercury	Big Trout Lake
Northern Pike	65-70cm	General	12	Mercury	Big Trout Lake
Northern Pike	70-75cm	General	12	Mercury	Big Trout Lake
Northern Pike	>75cm	Sensitive	0	Mercury	Big Trout Lake
Northern Pike	35-40cm	Sensitive	16	Mercury	Big Trout Lake
Northern Pike	40-45cm	Sensitive	16	Mercury	Big Trout Lake
Northern Pike	45-50cm	Sensitive	12	Mercury	Big Trout Lake
Northern Pike	50-55cm	Sensitive	8	Mercury	Big Trout Lake
Northern Pike	55-60cm	Sensitive	8	Mercury	Big Trout Lake
Northern Pike	60-65cm	Sensitive	4	Mercury	Big Trout Lake
Northern Pike	65-70cm	Sensitive	4	Mercury	Big Trout Lake
Northern Pike	70-75cm	Sensitive	4	Mercury	Big Trout Lake

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Fish common name	Fish length	Population consuming the fish	Maximum meals per month	Reason for advisory	Specific location
Walleye	>75cm	General	4	Mercury	Big Trout Lake
Walleye	25-30cm	General	32		Big Trout Lake
Walleye	30-35cm	General	32		Big Trout Lake
Walleye	35-40cm	General	32		Big Trout Lake
Walleye	40-45cm	General	16	Mercury	Big Trout Lake
Walleye	45-50cm	General	12	Mercury	Big Trout Lake
Walleye	50-55cm	General	8	Mercury	Big Trout Lake
Walleye	55-60cm	General	4	Mercury	Big Trout Lake
Walleye	60-65cm	General	4	Mercury	Big Trout Lake
Walleye	65-70cm	General	4	Mercury	Big Trout Lake
Walleye	70-75cm	General	4	Mercury	Big Trout Lake
Walleye	>75cm	Sensitive	0	Mercury	Big Trout Lake
Walleye	25-30cm	Sensitive	12	Mercury	Big Trout Lake
Walleye	30-35cm	Sensitive	12	Mercury	Big Trout Lake
Walleye	35-40cm	Sensitive	12	Mercury	Big Trout Lake
Walleye	40-45cm	Sensitive	8	Mercury	Big Trout Lake
Walleye	45-50cm	Sensitive	4	Mercury	Big Trout Lake
Walleye	50-55cm	Sensitive	4	Mercury	Big Trout Lake
Walleye	55-60cm	Sensitive	0	Mercury	Big Trout Lake
Walleye	60-65cm	Sensitive	0	Mercury	Big Trout Lake
Walleye	65-70cm	Sensitive	0	Mercury	Big Trout Lake
Walleye	70-75cm	Sensitive	0	Mercury	Big Trout Lake
Walleye	40-45cm	General	8	Mercury	Fawn Lake
Walleye	45-50cm	General	4	Mercury	Fawn Lake
Walleye	50-55cm	General	4	Mercury	Fawn Lake
Walleye	55-60cm	General	4	Mercury	Fawn Lake
Walleye	40-45cm	Sensitive	4	Mercury	Fawn Lake
Walleye	45-50cm	Sensitive	0	Mercury	Fawn Lake
Walleye	50-55cm	Sensitive	0	Mercury	Fawn Lake
Walleye	55-60cm	Sensitive	0	Mercury	Fawn Lake
White Sucker	40-45cm	General	32		Big Trout Lake
White Sucker	45-50cm	General	32		Big Trout Lake
White Sucker	50-55cm	General	32		Big Trout Lake
White Sucker	40-45cm	Sensitive	32		Big Trout Lake
White Sucker	45-50cm	Sensitive	16	Mercury	Big Trout Lake
White Sucker	50-55cm	Sensitive	12	Mercury	Big Trout Lake

4. BIRDS OF THE FAWN RIVER INDIGENOUS PROTECTED AREA

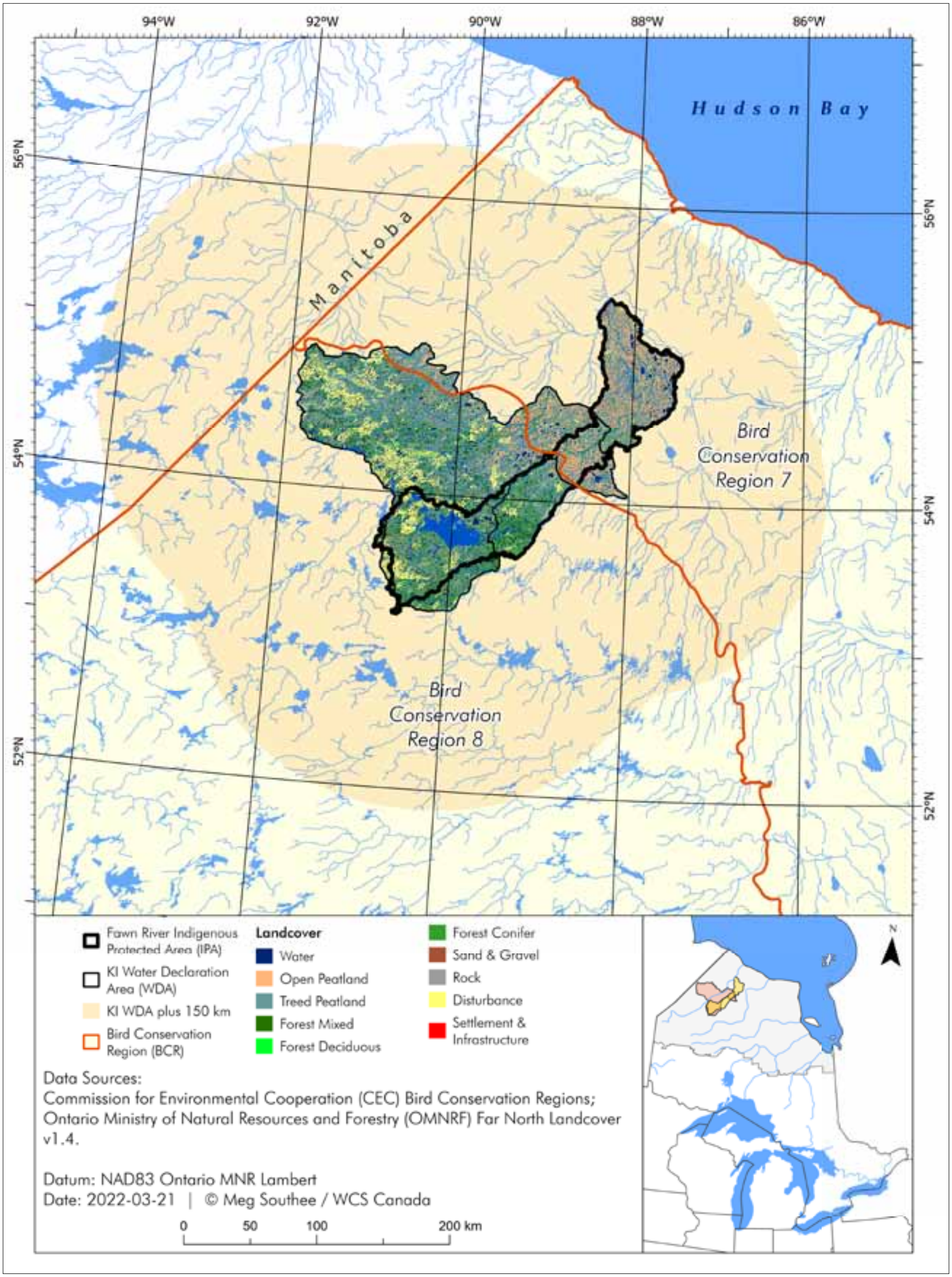
Prepared by Claire Farrell, Wildlife Conservation Society Canada

1. Introduction

One to two billion birds breed in the boreal region in Canada (Blancher 2003). The Canadian boreal forest holds over 50% of the world's populations for 40-50 species during breeding seasons (Blancher 2003). The Fawn River Indigenous Protected Area (IPA) and the surrounding northern lands and waters are home to many bird species, some of whom are migratory, using the area seasonally during long migrations north/south to winter or summer habitats. Conservation of birds in the Fawn River IPA is important not only for birds locally, but also for migratory bird populations associated with many other countries including the United States, Central and South America and the West Indies (EC 2013). The boreal region in northern Ontario is considered an important migratory corridor for many species of birds (FNSAP 2010).

The Fawn River IPA, located in this boreal region, plays an important role in the "continental responsibility" to protect and ensure bird population survival for future generations of birds and people (FNSAP 2010). More broadly, the forests, wetlands and shorelines that make up the Fawn River IPA represent globally important habitats for birds. For example, the boreal forest in this region is globally significant because it is part of the largest single block of boreal forest free from human development in the world (FNSAP 2010), while the northern wetlands and peatlands within the Fawn River IPA are part of the Hudson Bay Lowlands, North America's largest wetland and second largest peatland in the world (FNSAP 2010). These intact lands and waters provide food, water and transportation to First Nations communities and Indigenous Peoples as healthy bird populations, particularly waterfowl, remain an important cultural value for First Nations (Hlimi et al. 2012), including Kitchenuhmaykoosib Inninuwug (KI Cultural Atlas 2015).

Figure 1. The Fawn River IPA, KIWDA and KIWDA+150 km in relation to the Bird Conservation Regions 7 and 8.



Bird Conservation Regions and the Fawn River IPA

Government and scientific bodies across Canada refer to Bird Conservation Regions (BCRs) to characterize bird ecology and information at large spatial scales.

Birds fly, migrate and have different home-range sizes to meet their ecological needs (Jackson & Fahrig 2012) so it is important to consider bird ecology at multiple spatial scales. For example, government and scientific bodies across Canada refer to Bird Conservation Regions (BCRs) to characterize bird ecology and information at large spatial scales. BCRs were developed by scientists to support the integration of research and monitoring data as well as conservation actions for bird populations across multiple scales and jurisdictions, including national and international policy and legislation (e.g., *Migratory Birds Convention Act, 1994*[1], EC 2013).

I conducted a multi-scaled approach to help understand bird biodiversity in the Fawn River IPA with broadest ecological scale for bird conservation being the BCR scale (EC 2013, EC 2014). The area covered in this report is located within BCR 7 (Taiga Shield and Hudson Plains), which is 260,000 km^2 (EC 2013) and BCR 8 (Boreal Softwood Shield), which is 1,470,000 km^2 (Figure 1) (EC 2014).

Within the relevant BCRs, I selected three nested scales for analysis including: 1) the Fawn River IPA (~13,044 km^2); 2) Kitchenuhmaykoosib Inninuwug Water Declaration Area (KIWDA) (~23,500 km^2); and 3) the KIWDA together with a 150 km buffer (KIWDA+150 km) (~208,610 km^2) (Figure 1). The Fawn River IPA intersects with 2.1% and 0.5% of BCR 7 and BCR 8, respectively. The KIWDA covers 1.6% and 1.3% of BCR 7 and BCR 8, respectively (Table 1).

Table 1. Percentage area of Fawn River IPA and KIWDA within the Canadian Bird Conservation Regions (BCRs): BCR 7 (Taiga Shield and Hudson Plains) and BCR 8 (Boreal Softwood Shield). Area calculations for Fawn River IPA and KIWDA were calculated using spatial analysis tools.

	Bird Conservation Regions (BCRs)	
	BCR 7 (Taiga Shield and Hudson Plains)	**BCR 8 (Boreal Softwood Shield)**
Fawn River IPA	2.1% (5,531/260,000 km^2*)	0.5% (7,513/1,470,000 km^2**)
KIWDA	1.6% (4,098/260,000 km^2*)	1.3% (19,403/1,470,000 km^2**)

* EC 2013
** EC 2014

These scales were selected based on culturally and ecologically significant areas in and around the Fawn River IPA. The Fawn River IPA was established by KI to permanently protect their lands, waters and the animals and plants that use them, and is contained within the KIWDA as described in KI's Cultural Atlas. Both the Fawn River IPA and KIWDA are Indigenous-led approaches to conservation that may be highly relevant to bird conservation more broadly. The third spatial scale, KIWDA+150 km, includes a broader region of boreal forests and muskeg-rich peatlands that are important habitats for a diversity of bird species, particularly waterfowl (e.g., ducks) (Abraham 2014).

Land cover and important bird habitats

(Credit: Allan Lissner)

The diverse land types and waterbodies (land cover) that make up the Fawn River IPA and surrounding areas, are the result of variations in geology, hydrology, latitude and climate, among others, which influence ecosystem function and processes. These land cover types are used by scientists to classify different habitats for birds that are standardized to land cover types in order to determine when, where and how many different birds select and use these habitats seasonally and/or annually (see below). Scientists assume that habitat types are important proxies for factors that birds need to live and thrive, and support stable or increasing population growth.

We summarized the land cover types at three scales described above using a provincial land cover data layer, Provincial Land Cover Database (PLC2000[2]), since it was consistent with land covers described in BCR 7 and 8 (EC 2013, EC 2014).

The Fawn River IPA contains forests, water and wetlands. Sparse forests make up the largest proportion of the landscape (~31%), followed by treed bogs, typically black spruce and other shrubs (~15%), deep water as rivers and lakes (~15%), and different wetland habitats such as open bogs and open and treed fens (~22%) among the forest patches. Successional (growing) new-growth forests (~5%), burned forest (~3%), and dense coniferous, deciduous and mixed forest (~9% together), as well as some sand/gravel/mine tailing and infrastructure comprise the remaining land cover types in the Fawn River IPA (Figure 1, Appendix 1). These different land cover types provide a diversity of habitat types for different bird species.

The diverse land types and waterbodies (land cover) that make up the Fawn River IPA and surrounding areas are the result of variations in geology, hydrology, latitude and climate, among others, which influence ecosystem function and processes.

The KIWDA contains similar land cover types to the Fawn River IPA that is embedded within it. Roughly a third of the KIWDA is made up of sparse forest (~31%) and a quarter of other dense and regrowing forest (~23%). Deep rivers and lakes (~14%), as well as some shallow and sediment-rich waters, create a mosaic of wet landscapes, with many treed and open wetland habitats like fens and bogs making up ~31% of the KIWDA. Lastly, infrastructure and bedrock comprise the remaining land cover types (Figure 1, Appendix 2).

The Fawn River IPA straddles both BCR 7 (Taiga Shield and Hudson Plains) and BCR 8 (Boreal Softwood Shield) (EC 2013, EC 2014). The Taiga Shield and Hudson Plains region is rich in wetlands (77%) and full/sparse forests (20%), while remaining area in the region is made up of rivers, coastal lands and shrub and lichen-filled tundra land cover types (EC 2013). The Boreal Softwood Shield region is made up of more dense boreal forest (~60% by area), interspersed with wetlands (~12%), lakes and rivers (~12%), and other land cover types (EC 2014) (Figure 1). The majority of tree species are black spruce, but other trees like jack pine, tamarack, balsam fir, trembling aspen, balsam poplar and white birch are also present (Figure 1)(Thompson 2000, EC 2014). These tree species make up the forests typical of those found in the Fawn River IPA and KIWDA.

Different bird species rely on different habitat types, or land cover types, for the food they eat, the nests they build, or to manage other processes such as competition and predation, which affects how they live and their population dynamics in the Fawn River IPA. Scientists typically divide birds into groups based on their habitat requirements, grouping bird species that are ecologically similar in terms of their feeding, reproductive and habitat needs. I grouped birds in this section based on culturally (i.e., KI Cultural Atlas 2015) and ecologically significant groups including:

Rough-legged Hawk (Credit: Jeff Nadler)

1. Aerial Insectivores (birds that eat insects like swallows);
2. Birds of Prey (birds that hunt and eat meat like hawks and owls);
3. Eagles (Bald Eagle and Golden Eagle);
4. Forest and Shrub Birds (birds that live in the forest and shrub habitats like Canada Warbler);
5. Geese and Ducks (Canada Goose, Mallard);
6. Grassland and Tundra Birds (Tundra Swans);
7. Grouse and Grouse-like Birds (Ruffed Grouse, Willow Ptarmigan);
8. Loons (Common Loon, Red-throated Loon);
9. Scavengers (birds that eat carrion or scavenge for meat like Turkey Vulture and Common Raven);
10. Shorebirds, Gulls and Terns; and
11. Wetland and Water Birds (birds that use wetland habitats and lakes/rivers like herons, Belted Kingfisher and Double-crested Cormorants).

Aerial insectivores

Aerial insectivores are a group that require different habitats depending on the species. Common Nighthawk and Eastern Whip-poor-will typically use open habitats to forage and nest on the ground in areas near these open habitats. In the boreal forests they readily use wetlands, burned stands and clearcuts (Farrell et al. 2017, 2019). Bank Swallows, Tree Swallows, Barn Swallows and Cliff Swallows, as their name implies, use sandy banks, trees, cliffs and caves, or human structures like barns or nest boxes for nesting. These species often reuse nesting sites from year to year (Petersen 1955, Winkler et al. 2004, Saino et al. 2012) similar to Sharp-tailed Grouse that reuse leks, which are specific areas where male grouse congregate in competitive displays and courtship rituals. Identifying and protecting these habitats are important for ensuring viable nesting and foraging habitat for these birds in the future.

This group of species is highly threatened and is one of the fastest declining bird groups in Canada. Maintaining healthy insect populations, protecting lands and waters in these birds' habitats, particularly wetlands, are conservation actions suggested by the North American Bird Conservation Initiative Canada[3], or NABCIC (NABCIC 2019).

Eagles, birds of prey and scavengers

Eagles, birds of prey such as Osprey and Northern Harrier, and scavengers such as Common Raven are important generalists able to live in different environments including industrialized/urbanized areas (NABCIC 2019). Their habitat needs are related to their food, or prey. Prey includes species of fish, small mammals and/or carrion (typically ungulate carcasses such as moose, deer, and caribou). Their habitat requirements include clean water for healthy fish populations, as well as various wetland, shrub and forest habitat types used by small and large mammal species. Prey availability in the north, particularly of rodents like voles and snowshoe hares, can affect the distribution, abundance and population dynamics of bird predators such as owls (Côté et al. 2007), raptors and the Common Raven (Boutin et al. 1995). Snags (dead standing trees) used by eagles and other birds of prey such as Osprey are important for nesting as well as roosting (sleeping) and hunting perches (Miller & Miller 1980), and should be identified, monitored and protected in the Fawn River IPA.

Grouse and forest birds

Top, Long-eared Owl; bottom, Northern Parula (Credit: Jeff Nadler)

Forest birds, including grouse, are a diverse group and they have many different habitat needs. One way to understand this is to look at the land cover for the Fawn River IPA, KIWDA and KIWDA+150 km where there are different types of forest composition based on openness, age and species of trees (Figure 1). Forests are also a mosaic of plants and trees at different ages and stages including growth, regrowth, aging, dying and dead. Birds have evolved and adapted to use many of the habitats found in forests based on the successional pathways of growth and composition and may use the forest differently depending on their life cycle (e.g., nesting, breeding, overwintering).

For example, large snags are important to many cavity-nesting species and while forests containing snags are habitats for many species like chickadees, flycatchers, nuthatches and woodpeckers (Zack et al. 2002, Pilgrim et al. 2020), live trees are important for many other birds especially warbler species like Northern Parula. Scientists note that forests containing only one or two tree species (e.g., plantations, forests managed for timber) are equivalent to deserts for birds (and other species) because they do not provide the diversity of habitats and food sources needed (NABCIC 2019).

Sharp-tailed Grouse have specialized habitat requirements and use muskeg or open areas for leks during mating seasons (Tsuji et al. 1992, Tsuji 1996). They also seek more treed, covered areas further south during the winter months. Indigenous Knowledge in the region suggests Sharp-tailed Grouse reuse leks every year (Tsuji 1996). Leks should be monitored and protected as breeding habitat.

Shorebirds, gulls and terns

While the coastlines of the Hudson and James Bays are well known for providing habitat for many migrating shorebirds (Abraham et al. 2011), the Fawn River IPA and surrounding area also support shorebirds. Marshy areas, wetlands and lake and river shorelines (Albanese & Davis 2015) can provide critical stopover habitat for these birds to rest and feed during migration or wintering (FNSAP 2010, NABCIC 2019). In particular, interior wetland habitats are crucial for providing the resources (food) that shorebirds need when migrating to and from wintering grounds (Skagen et al. 1999).

Interior wetland habitats are crucial for providing the resources (food) that shorebirds need when migrating to and from wintering ground.

The quality of stopover habitats affects migrating shorebirds in many ways. For example, the amount of food sources available, condition of the habitat, adverse weather and disturbance in these areas can alter and impact migration and breeding success (Skagen 2006). The landscapes surrounding shorebird stopover sites are important as well: in more southern areas, shorebird abundance was correlated with more wetlands at larger landscape scales (Albanese & Davis 2015). Some shorebirds, like Semipalmated Plover, return to the same stopover areas year after year (Smith & Houghton 1984), emphasizing the importance of protecting stopover sites used in migration by shorebirds.

Loons, geese and ducks, wetlands and water birds

Wetlands, lakes and the areas surrounding them are important to wetland and water species and waterfowl including many geese, ducks and loons. These areas are important for breeding habitat as well as migratory species in this group that use these wet habitats for stopover and staging sites – where shorter or longer rests and refueling is done to aid migration (Warnock 2010).


American bittern (Credit: Jeff Nadler)

The NABCIC states that population recovery over the past decades for many waterfowl and wetland birds is due to the conservation and protection of wetlands in Canada and North America (NABCIC 2019). Boreal ducks/waterfowl have been known to use wetlands extensively, however their use of wetlands can differ based on prey (insect) availability (Nummi et al. 2012) and wetland type (beaver pond versus marsh wetland) (Rempel et al. 1997). Therefore, different wetland habitat types may be more important to certain species. Generally speaking, wetlands are universally important for this group of birds. Loons, an important cultural species, typically use inlets and islands on lakes for their nests. They are also known to reuse these sites year to year (Strong et al. 1987).

Overall, because bird species have unique habitat needs, even within their respective groups, it is difficult to summarize all the important habitat for species in the Fawn River IPA into general terms. However, healthy forests, waters, wetlands and prey (food) sources are integral to bird nesting, foraging and migration success of the bird groups and species observed in the Fawn River IPA and beyond (see below). Furthermore, many bird species, such as Common Loon, waterfowl and shorebirds, aerial insectivores, and Sharp-tailed Grouse, show site fidelity and reuse nesting, stopover and breeding areas. As such, it is important to identify these areas, monitor their use and productivity and protect them.

Common Loon (Credit: Jeff Nadler)

Natural disturbance and birds

Biodiversity in boreal regions is driven by, and adapted to, natural disturbances such as forest fires (Rowe & Scotter 1973, McRae et al. 2001, Swanson et al. 2010). Forest fires create open areas in the boreal forest and roughly 3% of land cover in the Fawn River IPA was classified as burned at one time (Appendix 1). Many bird species rely on open habitat areas created by fires, including bird species that are in decline in North America (DeGraaf & Yamasaki, 2003). For example, both Common Nighthawk and Eastern Whip-poor-will are considered species at risk that use open areas created by fires in the boreal forest (Farrell et al. 2017, 2019). These open areas, including forest opening and wetlands, allow birds like Eastern Whip-poor-will to catch flying insects on-the-wing (ECCC 2018). Boreal wetlands affect their occupancy in forested landscapes (Farrell et al. 2019) by providing both open areas for hunting and high densities of insect prey for these and other birds (Spitzer & Danks 2006). Fire suppression and clearcutting associated with commercial forestry impact species by changing natural fire regimes that in turn affect food sources, habitat types and dynamics with competitors and predators. Scientists have suggested that declines in some species, including aerial insectivore bird species like Common Nighthawk and Eastern Whip-poor-will, could be due to the lack of open areas in the boreal as a result of fire suppression practices by humans (Tozer et al. 2014, Purves 2015).

Forest fires can also change many habitat characteristics like the amount of light, moisture and nutrient conditions in an area, increasing habitat complexity and creating forests of varying age classes over time (Swanson et al. 2010). These changes alter food availability, plant regrowth and suitable habitat for nesting and residency (EC 2013, EC 2014). The more northern and remote BCR 7 remains largely intact and has a high degree of ecological integrity with limited human disturbance. As such, fire remains one of the dominant forces shaping the land cover (EC 2013) ultimately determining which types of birds may use the landscape and when and where they can live there. Climate change is, and will continue, to affect the frequency and severity of forest fires across the boreal (see Climate change below)(Williamson et al. 2009).

Other effective conservation measures for bird conservation

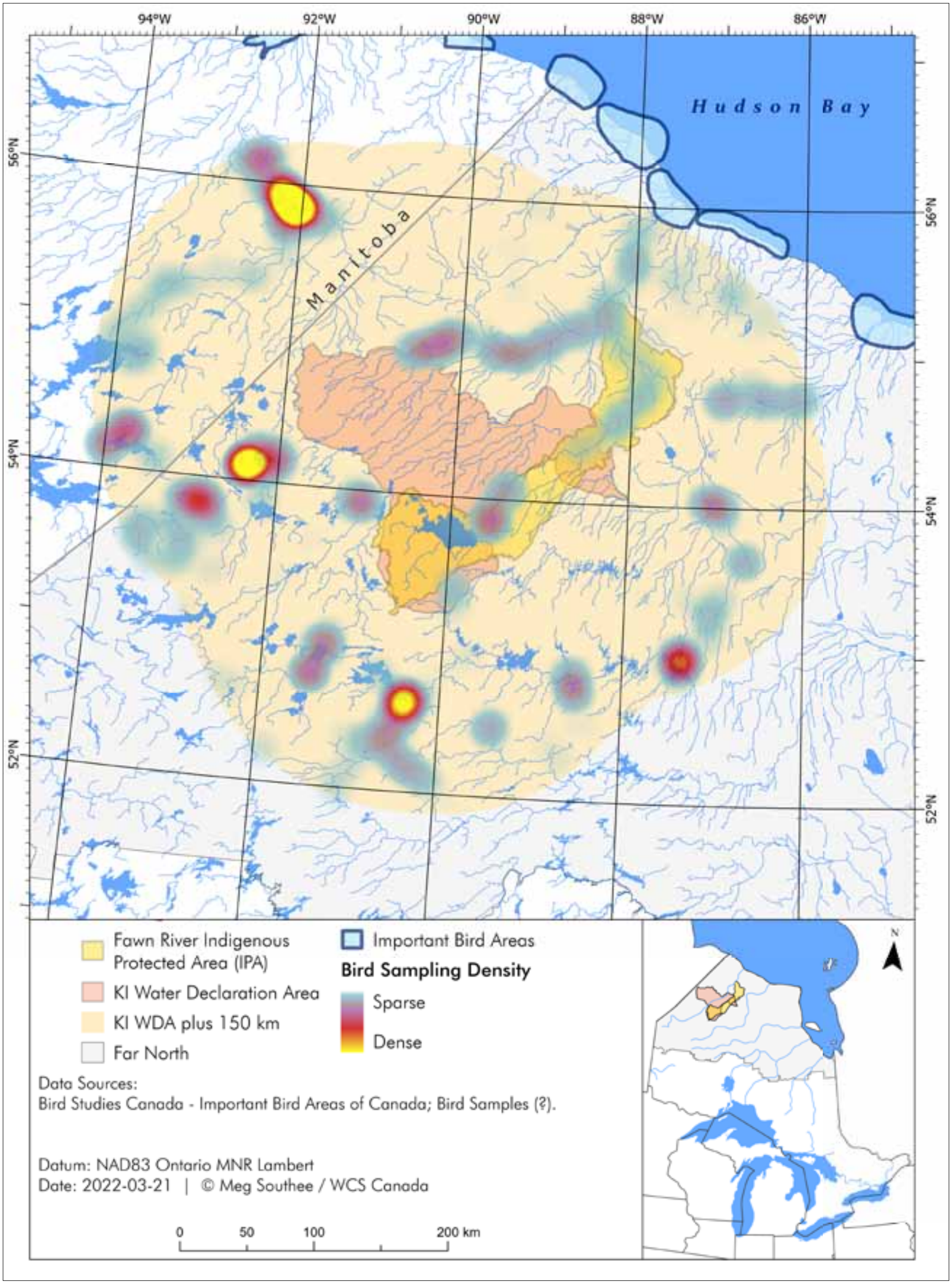
Red Knot rufa subspecies (Calidris canutus rufa) is an endangered shorebird in Ontario, requiring adequate food resources before and during migration in order to survive. Migratory shorebirds have been observed within the Fawn River IPA suggesting it may be an important migration stopover site.

There are a number of other designations that may be meaningful for bird conservation in and around the Fawn River IPA, specifically Important Bird Areas (IBAs). An IBA is a "site that supports specific groups of birds" (e.g., shorebirds), as well as "threatened birds, large groups of birds, and birds restricted by range or habitat"(Important Bird Area (IBA) Canada). Currently, IBAs are north of the Fawn River IPA and located primarily along the shores of Hudson Bay (Figure 2), mainly for their role as habitat for the hundreds of thousands of migratory birds that move through the far north to breeding grounds in the Arctic during the spring and summer or south during the winter (FNSAP 2010: 33, 36).

Though no areas of the Fawn River IPA nor KIWDA have been designated as an IBA, this area does occur within a migration corridor leading northward to these IBAs and host many of these important birds that migrate to and from southern areas (FNSAP 2010, EC 2013, 2014). Habitat like the Fawn River IPA can provide stopover sites for birds migrating north or south (EC 2013). These stopover sites are very important for ensuring birds' survival and successful migration (Hutto 1998). For example, scientific studies have shown that Red Knot rufa subspecies (*Calidris canutus rufa*) is an endangered shorebird in Ontario, requiring adequate food resources before and during migration in order to survive (Baker et al. 2004, Morrison 2006). Migratory shorebirds have been observed within the Fawn River IPA suggesting it may be an important migration stopover site.

Another important conservation designation is a Key Biodiversity Area (KBA). KBAs are "areas that are exceptionally important for wildlife and biodiversity"[4]. Potential Canadian KBAs are identified based on a Canadian adaptation of the Global Standard for the Identification of Key Biodiversity Areas (KBA Canada Coalition 2021). Certain IBAs may also be KBAs based on these criteria. One of the criterion is based on the Endangered and Threatened status of species. For example, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) conducts a scientific review of species information. In addition, places and areas that are important to a species survival such as staging, breeding and nursery areas may also identify a KBA. Finally, KBAs may be identified based on the level of ecological integrity measured as intactness and a lack of human development. KBAs in Canada may also be globally recognized depending on the species and criteria being considered. KBA identification in northern Ontario is just beginning.

Figure 2. Bird sampling density across the three scales of analysis for birds as well as the locations of Important Bird Areas downstream from the Fawn River IPA.



2. Bird biodiversity of the Fawn River IPA

There are 462 recognized bird species in Canada (Environment and Climate Change Canada & Canadian Wildlife Federation n.d.). Many of these species occur in the Fawn River IPA as it straddles both BCR 7 and 8. For example, BCR 8 holds over 10% of the world's population of 10 breeding bird species alone (EC 2014) and together with BCR 7 provide homes and habitats for many different species of birds, some of whom are at risk of extinction (EC 2013, EC 2014).

To better understand what information is available about bird biodiversity in the Fawn River IPA, I used publicly available bird data sources to describe the biodiversity and number of bird observations within the above 11 groups of birds across the three spatial extents, including and surrounding the IPA. The bird groups were created to include culturally and ecologically significant bird species and these groups are important to understanding bird biodiversity within the Fawn River IPA and surrounding areas.

There are 462 recognized bird species in Canada. Many of these species occur in the Fawn River IPA as it straddles both BCR 7 and 8.

I used the bird data to describe what species at risk have also been documented as occurring within each of the three spatial extents. Species at risk are birds that are considered at risk ecologically – meaning they are at risk of extinction and are likely declining. The Committee on the Status of Species at Risk in Ontario (COSSARO) and COSEWIC are the provincial and federal agencies, respectively, that use scientific information to determine what species are at risk, what can be done about their recovery and provide funding for research and monitoring of species at risk.

I searched the respective provincial and federal species at risk public registries to find documents relating to bird species that were designated under the federal *Species at Risk Act* (SARA) and/or Ontario's *Endangered Species Act, 2007* (OESA) that occurred within the study areas described above. I did not include species that are designated Extirpated (e.g., no longer found in Ontario) or Extinct (e.g., not found anywhere in the world). The list of provincial (n = 42) and federal (n = 58) species at risk included species designated as Special Concern (e.g., there is enough scientific information available for decision making), Threatened, Endangered, as well as Data Deficient or No Status.

Methods

Data sources

NatureCounts is a website and database that allows users to collect, archive, interpret and access wildlife data to advance the understanding of bird populations across the Western Hemisphere. NatureCounts is managed by Birds Canada, a volunteer-based non-profit charity that aims to conserve birds through science-based actions, partnerships, advocacy and engagement was used to obtain information about birds in the area in and around the Fawn River IPA. Bird data from a number of sources were requested, including scientific surveys (e.g., Abraham 2014), citizen science (e.g., Cooper et al. 2014), community knowledge (e.g., Charles et al. 2020), phone applications, programs and events within NatureCounts. Bird data were obtained for an area that included the Fawn River IPA as well as the two broader spatial scales described above. I clipped this data to each of the three spatial scales using ArcMap software (Figure 1).

After clipping the bird data to the three extents, the following datasets were assessed: Ontario Breeding Bird Atlas, Manitoba Breeding Bird Atlas, Project FeederWatch, Project NestWatch and eBird (Table 2). The Ontario Breeding Bird Survey (BBS), Great Backyard Bird Count and the Ontario Eastern Whip-poor-will Project were also examined (Table 2), but these datasets did not include any observations within the three spatial scales.

Bird observations in these different datasets are collected using different protocols and methods. For example, point counts are used to collect bird data for the Ontario and Manitoba Breeding Bird Atlases. Point counts are a scientific sampling approach where expert observers, typically volunteers, listen at 25 unique places (points) in pre-selected areas and record the birds that they hear or see at the point (Table 2). Experts need to be able to identify the bird by its song and/or sight for this data to be accurate. Data are also collected on the habitat or land cover where the birds are seen or heard. These data are submitted to Birds Canada, which reviews, compiles and manages the datasets.

Point counts are used to collect bird data for the Ontario and Manitoba Breeding Bird Atlases. Point counts are a scientific sampling approach where expert observers, typically volunteers, listen at 25 unique places (points) in pre-selected areas and record the birds that they hear or see at the point.

Consequently, when I discuss bird observations in this section, it is likely they are different types of data from different sources that are publicly available. For example, an observation may include birds or a group of birds (colony) that were seen or heard by citizen scientists, experts or local volunteers (Table 2).

Surveys for 2010-2014 and 2001-2005 for all Breeding Bird Atlas data available for Manitoba and Ontario were used. I used the highest breeding evidence per square data from these surveys as the main way to classify the biodiversity (or number of types of birds) in the Fawn River IPA and surrounding areas where a square represents a 10 km by 10 km sampling square of the Breeding Bird Atlas. The highest evidence of breeding means all types of birds were included.

This approach provides the most observations for the purposes of describing bird biodiversity in this study. All rare species and colonial data obtained from the Breeding Bird Atlases were used to provide observations on rarer birds and colonies observed during point counts. As I used different data sources, there is an uneven distribution of information about birds in and around the Fawn River IPA. In Figure 2, I show the distribution of bird sampling density from sparse to dense – these hotspots identify areas where there are many data points containing information about birds (dense) and areas where there are few to no data points (sparse). I used a statistical package called R to develop these analyses (R Core Team 2015).

Measuring biodiversity and looking at groups of birds

Biodiversity was measured as the total number of unique species (types of birds) in all datasets at all three spatial scales. In any instance where the exact species was not identified (e.g., bird was only identified as "duck species") in the dataset, it was not included in the count of total biodiversity. However, if an observation did not have the species identified, it was still included in the total count of observations in a *group* of birds. For example, an observation of "duck species" would still be counted in the total number of observations, like those for "geese and ducks".

Table 2. Bird data sources used in this atlas, as well as description of program/project, how data are collected and relevant links to program/project

Dataset	Description of program/project	How is information about birds collected?	Link
Ontario Breeding Bird Atlas	Over a period of five years, volunteer birders (scientists, citizen scientists, bird hobbyists) count and record birds in pre-selected areas or squares, in Ontario. Data from these five years are compiled into the Ontario Breeding Bird Atlas for that time period. The atlas is revised about every 20 years. Previous atlases were completed for 1981-1985 and 2001-2005. The next atlas starts in 2021 and current Canadian Wildlife Service surveys are part of the collection sources for the 2021-2025 atlas. The 2021-2025 Ontario Breeding Bird Atlas is a partnership between organizations: Birds Canada, Canadian Wildlife Service – Environment and Climate Change Canada (Government of Canada), Ministry of Natural Resource and Forestry (Government of Ontario), the Ontario Field Ornithologists and Ontario Nature – a nature/conservation based charity.	All of Ontario is divided into 10 km by 10 km squares. Citizen scientists work within a square and conduct point counts at pre-selected locations during the spring breeding season (roughly May-July). One point count is five minutes long and observers primarily listen but also look for all possible bird species during one point count. Twenty-five point counts are required within one square to consider that square completed for the atlas. In more northern, remote regions, only a sample of the squares are selected for completion in a given atlas, as determined by Ontario Breeding Bird Atlas. Information for Indigenous communities to get involved with Atlas -3 can be found at https://www.birdsontario.org/indigenous-engagement/communities/	https://www.birdsontario.org/
Manitoba Breeding Bird Atlas	Over a period of five years, volunteer birders (scientists, citizen scientists, bird hobbyists) count and record birds in pre-selected areas or squares, in Manitoba. Data from those five years are compiled into the Manitoba Breeding Bird Atlas for that time period. The first atlas was completed for 2010-2014.	All of Manitoba is divided into 10 km by 10 km squares. Pre-selected locations are determined by organizers within each square and citizen scientists complete roadside or off-road point counts during the spring breeding season (roughly May-July). Point counts are where observers primarily listen to but also look for all possible birds within a five-minute period. The minimum number of point counts in each square is 15, however in less remote regions, more point counts are completed to increase the amount of data collected.	https://www.birdatlas.mb.ca/accounts/methods_en.jsp
Project FeederWatch	A research project run by Birds Canada and the Cornell Lab of Ornithology, where citizen scientists submit winter bird sightings at their bird feeders across Canada and the United States Data are then compiled by the program, making sure important information about the species of bird, location and date is retained (Project FeederWatch 2021).	Any person with a bird feeder that attracts birds can participate in Project FeederWatch. During the winter (November-April) any person in Canada or the United States can submit bird observations to Project FeederWatch through its website. (Project FeederWatch 2021).	https://feederwatch.org/about/project-overview/
Project NestWatch	A long-term monitoring program run by Birds Canada in collaboration with Environment and Climate Change Canada (Government of Canada), where scientists and citizen scientists submit nest observations about breeding birds in Canada. Data are then compiled by Birds Canada, making sure important information about the species of bird that made the nest, the nest condition, location and date are retained (Project NestWatch 2021).	Participants in Canada and the United States register with NatureCounts to contribute data to Project NestWatch. Participants then search for nests near their area of interest and submit any nest observations and information associated with those observations (e.g., the species of bird) to NatureCounts. Participants must abide by a code of conduct for the project, making sure to reduce contact and interference with breeding birds. Permits are sometimes required for observing the nests of birds considered species at risk.	https://www.birdscanada.org/bird-science/project-nestwatch/

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Dataset	Description of program/project	How is information about birds collected?	Link
eBird	eBird is a program and phone app run by the Cornell Lab of Ornithology where citizen scientists around the world can submit the pictures or songs of birds they have seen in their area. Data are compiled into maps and datasets by eBird/the Cornell Lab of Ornithology (eBird 2021).	Any person in any location in the world can submit bird observations of birds they've seen or heard using the eBird phone app. Observations are not limited to a specific time period, so citizen scientists/users of eBird can submit observations at any time during the year.	http://www.ebird.org
Ontario Breeding Bird Survey (BBS)	The primary source of information on long-term bird population trends across the continent, including Ontario. This is a collaborative program run by Birds Canada with Environment and Climate Change Canada (Govenrment of Canada).	Skilled observers survey pre-determined BBS routes one day per year between May 28 and July 7. They identify all birds along the route by sight and sound.	https://www.birdscanada.org/bird-science/breeding-bird-survey/
Great Backyard Bird Count	An annual four-day event that relies on bird enthusiasts to identify and count the birds they see at their feeders and in their backyards to create a ""snapshot"" of where birds are each day. This is a collaborative project between the Cornell Lab of Ornithology, Audubon, and Birds Canada.	Anyone can participate by deciding where they may watch birds for 15 minutes or more, at least once over the four days. Participants count all the birds they see or hear within the time and location and enter their data using various applications including Merlin Bird ID and eBird Mobile. Participants can download a checklist of birds to help identify birds as well as instructional videos to help with data entry.	https://www.birdcount.org/
Ontario Eastern Whip-poor-will Project	A specific project launched in 2010 to investigate the occurrence of Eastern Whip-poor-wills in Ontario. While the specific project has concludedm observations are still being collected by volunteers and citizen scientists through the Canadian Nightjar Survey project as well as through eBird and the Ontario Breeding Bird Atlas (OBBS).	Anyone can participate if they hear or see Eastern Whip-poor-wills which tend to occur in breed in Ontario during May-July. Specific information on survey times and routes are available on the website.	https://www.birdscanada.org/naturecounts/wpwi/main.jsp

Pileated Woodpecker (Credit: Jeff Nadler)

I describe bird biodiversity based on the following 11 groups:

1. Aerial Insectivores (birds that eat insects like swallows);
2. Birds of Prey (birds that hunt and eat meat like hawks and owls);
3. Eagles (Bald Eagle and Golden Eagle);
4. Forest and Shrub Birds (birds that live in the forest and shrub habitats like Canada Warbler);
5. Geese and Ducks (Canada Goose, Mallard);
6. Grassland and Tundra Birds (Tundra Swans);
7. Grouse and Grouse-like Birds (Ruffed Grouse, Willow Ptarmigan);
8. Loons (Common Loon, Red-throated Loon);
9. Scavengers (birds that eat carrion or scavenge for meat like Turkey Vulture and Common Raven);
10. Shorebirds, Gulls and Terns; and
11. Wetland and Water Birds (birds that use wetland habitats and lakes/rivers like herons, Belted Kingfisher and Double-crested Cormorants).

Results

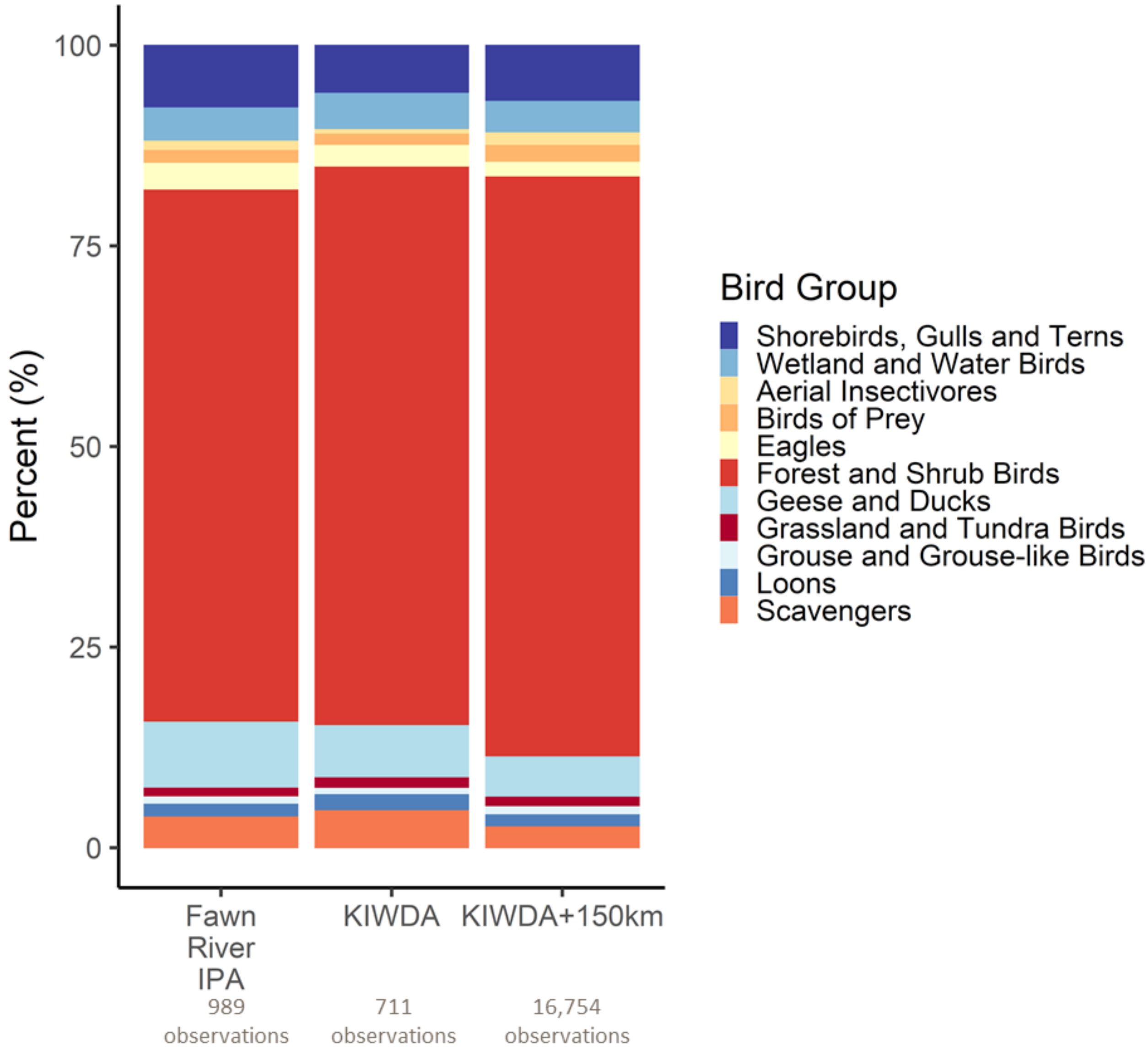
Bird biodiversity in the Fawn River IPA

There are 989 individual observations of birds in the Fawn River IPA (Figure 3). These account for 108 unique bird species observed in the Fawn River IPA (Appendix 3). The bird biodiversity of this area is 0.008 species/km^2.

Forest and shrub birds make up 66.2% of the bird observations in the Fawn River IPA (Figure 4, Table 3, Appendix 4). Fifty-three forest and shrub bird species were observed, mainly songbirds and perching birds such as sparrows, warblers, chickadees and woodpeckers (Appendix 3).

Forest and shrub birds have the highest observed biodiversity of any group in the Fawn River IPA (Figure 4, Table 3, Appendix 4). However, it is important to consider that both land cover and the way data were collected might affect which birds are observed. First, roughly ~30.8% of the Fawn River IPA is made up of sparse forests land cover types, with dense and younger forests making up much of the remainder of the area. Therefore, about 60% of the Fawn River IPA is considered forest or forested (Figure 1, Figure 3, Appendix 1). Many forest and shrub bird species use these kinds of forest habitats, which could account for why so many species in this group have been documented. Second, forest and shrub birds like boreal songbirds and migrating perching birds are more easily identified by their songs and calls that are unique to each species. Because of this, these birds are more easily detected in point-count based surveys associated with the different data sources for this research, as opposed to other species like waterfowl (geese and ducks), which aren't as easily detected by their song or call. For example, data are collected for the Breeding Birds Atlas using point counts (Table 2). Songbirds, which are typically forest and shrub birds, are more easily heard and likely to be recorded as observed and included in the Atlas. Boreal monitoring of some important bird groups (e.g., shorebirds, land birds, sea birds and inland waterbirds) have data gaps and biases because of these known monitoring challenges (e.g., remoteness of area).

Figure 3. Percent proportion of all bird observations in the Fawn River IPA, KIWDA and KIWDA+150 km. Colours represent 11 culturally and ecologically important bird groupings described in more detail in the text. (Credit: Lucy Poley)



Geese and ducks, a bird group that has both cultural and ecological significance, comprise the next most abundant group based on the number of observations (8.2%) (Figure 4, Table 3, Appendix 4). This group is the second-most diverse with 14 different species of geese and duck observed including many types of duck (e.g., shovelers, scaups, mergansers) and geese (e.g., Canada Goose) (Figure 4, Table 3, Appendix 3).

Top, Canada Geese; middle, Northern Shoveler; bottom, Baird's Sandpiper (Credit: Jeff Nadler)

Canada Geese are known to breed in high numbers in the Hudson Bay Lowlands region (Abraham 2014). Canada Geese and other species such as Common Merganser and Wood Duck are also found in the Fawn River IPA and considered stable or increasing based on other data not included in this study (Blancher et al. 2009, Abraham et al. 2014).

A number of species observed in the Fawn River IPA are considered uncommon breeders (e.g., Greater Scaup), uncommon migrants (e.g., Northern Shoveler), or species in decline in the BCR (e.g., American Wigeon, Green-winged Teal) (Appendix 3)(Abraham 2014). A large portion (15%) of the Fawn River IPA is made up of deep, clear water as well as wetlands (Figure 3, Appendix 1). These waters and wetlands are essential habitats for geese and ducks, which specialize in aquatic environments to feed, build nests and reproduce in.

Shorebirds, gulls and terns are the third-most abundant bird group in the Fawn River IPA based on observations (7.8%) (Figure 4, Table 3, Appendix 4). This group includes 12 unique species of shorebirds and gulls (Appendix 3). The Fawn River IPA includes a network of lakes and rivers creating important shoreline environments for shorebirds to feed, nest and reproduce among (Figure 3).

Observations of long-distance migratory shorebirds including Spotted Sandpiper, Semipalmated Plover, Black-bellied Plover, Greater Yellowlegs and others highlight why this area is important for birds, particularly shorebirds (Figure 4, Appendix 3, Appendix 8). This area is part of a migration corridor for migratory birds, providing a stopover site (FNSAP 2010, EC 2013). This area also provides important habitat for Arctic-breeding species including Spotted Sandpiper, Least Sandpiper and Solitary Sandpiper, all of which are found in the Fawn River IPA.

Migrating birds made up 85.5% of observations in the Fawn River IPA and included birds from many groups including shorebirds (Appendix 3, Appendix 4). Overall, the bird biodiversity observed in the relatively small area of the Fawn River IPA reinforces the importance of the area for many different species of migrating birds.

Figure 4. Percentage of observations in each of the 11 culturally and ecologically important bird groups in the Fawn River IPA. Birds illustrated are species found in the Fawn River IPA that use a variety of habitats for nesting, foraging and resting. Bird species from left to right, top to bottom include: shorebird and gull silhouettes, Greater Yellowlegs, Black-bellied Plover, Bay-breasted Warbler, Cape May Warbler, Pileated Woodpecker, Canada Goose silhouettes, Common Loon. (Credit: Lucy Poley)

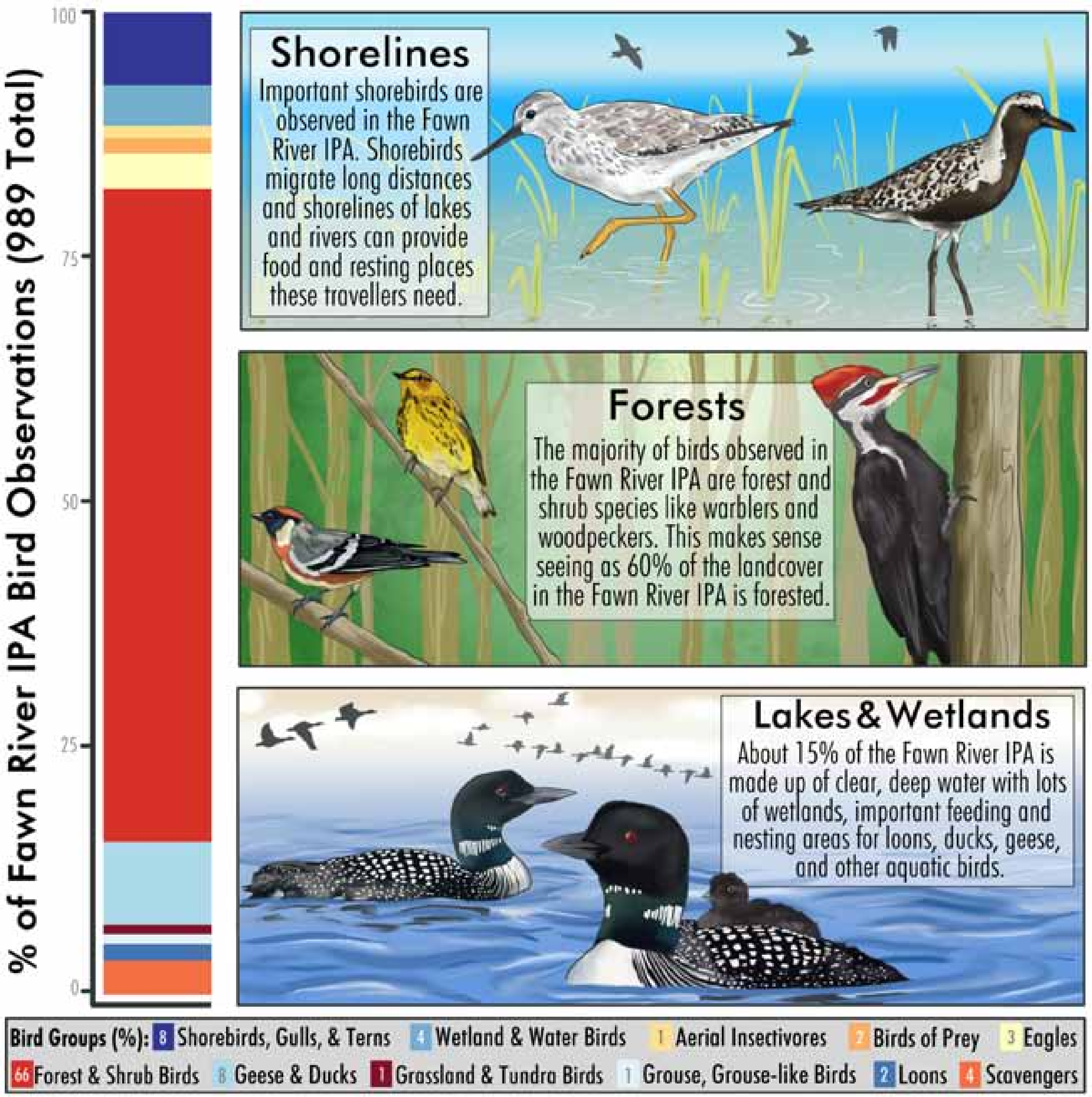


Table 3. All bird observations recorded in the Fawn River IPA, KIWDA and KIWDA+150 km in each of 11 culturally and ecologically important bird groups.

	Fawn River IPA 989 Observations 108 Species		KIWDA 711 Observations 91 Species		KIWDA+150 km 16,574 Observations 196 Species	
Bird Group	**Percent (%) of Total Observations**	**Number of Species in Group**	**Percent (%) of Total Observations**	**Number of Species in Group**	**Percent (%) of Total Observations**	**Number of Species in Group**
Aerial Insectivores	1.3	3	0.7	1	1.7	6
Birds of Prey	1.6	7	1.4	6	2.1	17
Eagles	3.3	2	2.7	1	1.8	2
Forest and Shrub Birds	66.2	53	69.6	50	72.2	91
Geese and Ducks	8.2	14	6.5	11	5	24
Grassland and Tundra Birds	1.1	3	1.3	2	1.2	9
Grouse and Grouse-like Birds	0.9	4	0.8	2	1	4
Loons	1.6	1	2	1	1.5	2
Scavengers	3.8	2	4.6	2	2.6	3
Shorebirds, Gulls and Terns	7.8	12	6	9	7	24
Wetland and Water Birds	4	7	4.4	6	3.8	14

Observations were detected of culturally important birds like eagles (3.3%), grouse (0.9%) and loons (1.6%) in the Fawn River IPA (Figure 4, Table 3, Appendix 4). Bald Eagle, Ruffed/Spruce/Sharp-tailed Grouse, Willow Ptarmigan and Common Loon have all been observed in the Fawn River IPA (Figure 4, Table 3, Appendix 3).

Birds were detected in small numbers from all other bird groups in the Fawn River IPA, both in observations as well as species count. Three species of aerial insectivores (1.3% of observations), seven species of birds of prey (1.6% of observations), three species of grassland and tundra birds (1.1% of observations), two species of scavengers (3.8% of observations), and seven species of wetland and water birds (4.0% of observations) were recorded (Figure 4, Table 3, Appendix 3).

Species at risk in the Fawn River IPA

A small (6%), but significant, proportion of observations and species in the Fawn River IPA are classified as species at risk by provincial or federal regulators or both. About one in every 20 observations (5.4%) was of a species at risk (Figure 5, Table 4). Species at risk included Rusty Blackbird, Bald Eagle, Common Nighthawk, Olive-sided Flycatcher, Golden Eagle and Bank Swallow (Figure 6, Table 4).

One-third of the species at risk found in the Fawn River IPA is significantly at risk of extirpation because their populations are threatened or endangered throughout their range in Ontario or Canada (Figure 5). Golden Eagle and Bank Swallow in the Fawn River IPA are considered Endangered and Threatened, respectively, while the remaining species at risk are considered of Special Concern (Table 4, Figure 6).

Bald Eagle (Credit: Jeff Nadler)

There are implications for species protection because species at risk were found within and surrounding the Fawn River IPA. When a species is listed as either Threatened, Endangered or Extirpated, protections under SARA on federal lands such as reserve lands are triggered. As such, special permissions are required for any activities that affect these species and it is forbidden to kill, harm, harass or capture these species. Future research or monitoring within and surrounding the Fawn River IPA could focus on these and other species at risk to establish protection for birds at risk as well as their habitats within the IPA.

Bird biodiversity in the KIWDA and KIWDA+150 km

Compared to the Fawn River IPA, the biodiversity in the KIWDA was lower despite the fact that the KIWDA encompasses a larger area: having only 91 species of birds total and 0.004 species/km^2 (roughly half that of the IPA). However, I do not account for uneven sampling effort when comparing datasets for birds based on different spatial extents and the Fawn River IPA also has more data points (n=989) compared to the larger KIWDA (n=711).

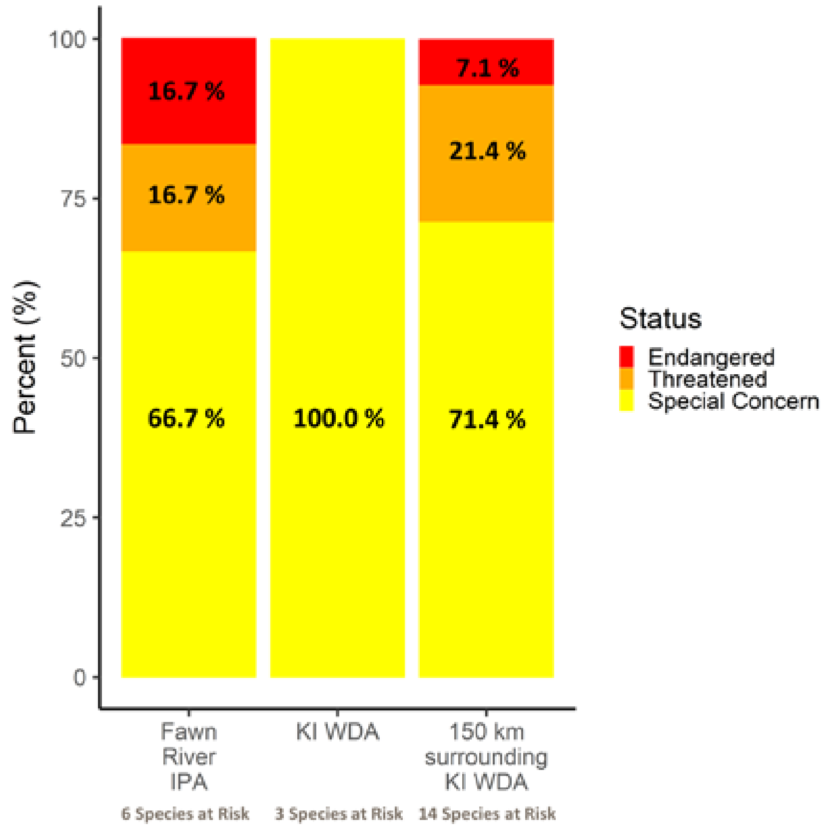
When we consider the largest spatial scale (KIWDA+150 km), there are 196 species of birds within 208,610 km^2 based on 16,754 observations.

Finally, at the largest spatial scale (KIWDA+150 km), there are 196 species of birds within 208,610 km^2 based on 16,754 observations. Biodiversity at this largest scale is 9 species/km^2, which is much higher compared to the KIWDA and Fawn River IPA.

There is a similar species and composition pattern to the Fawn River IPA at these larger extents (Figure 4). Most bird observations in the KIWDA and KIWDA+150 km are forest and shrub birds (Table 3, Appendix 4). The majority (86.1%) of the bird species are forest birds like songbirds and perching birds. Similarly, the next most diverse group of birds is geese and ducks, with 11 species and 24 species in the KIWDA and KIWDA+150 km, respectively (Figure 4, Table 3, Appendix 4).

Notably, shorebirds, gulls and terns account for a significant portion of the species and observations of birds in the KIWDA (6%) and KIWDA+150 km (7.0%). This could be due to the fact that areas north of the Fawn River IPA and KIWDA are located in the Hudson Bay Lowlands and associated shorelines, which are used by millions of breeding shorebirds annually (FNSAP 2010). For example, 83% of bird observations were of migratory birds at these two extents, suggesting many migratory birds use this region during their migration north and south.

Figure 5. Species at risk observed in the Fawn River IPA, KIWDA and KIWDA+150 km. Status is based on the highest-risk designation made under provincial and federal processes.



An observation of Hudsonian Godwit within the KIWDA+150 km spatial scale is particularly interesting (Appendix 3). The Hudsonian Godwit is a shorebird that only breeds in a relatively small region of the shores on Hudson Bay and migrates during the summer from the northwest to areas in boreal/Arctic region (COSEWIC 2019). The observation shows that rare species, often associated with more northerly IBAs, may also use the Fawn River IPA intermittently. This provides further support for the importance of the Fawn River IPA as habitat for foraging and breeding migratory shorebirds (Figure 3).

The rest of the species and their observations include: aerial insectivores, birds of prey, eagles, grassland and tundra birds, scavengers, and wetland and water birds (Figure 4). Each group accounts for less than 5% of observations at both spatial scales (Figure 4, Table 4, Appendix 4).

Culturally important species are also found at both larger extents including eagles, geese and ducks, grouse and grouse-like birds, and loons (Figure 4, Table 4, Appendix 4). Overall, the biodiversity and species found at all three spatial scales are relatively similar. Almost all species that were observed in the Fawn River IPA were also observed in the KIWDA, and/or KIWDA+150 km (Appendix 3, Appendix 4). For example, Common Loon, Bald Eagle and Canada Goose were observed at all three spatial extents and Sharp-tailed Grouse was observed in the Fawn River IPA and KIWDA+150 km.

Figure 6. Species at risk observed in the Fawn River IPA and their risk level based on the highest provincial or federal designation under species at risk legislation and assessment processes. (Credit: Lucy Poley)

Of the 94 species in the KIWDA, three are designated at risk and all are designated Special Concern, including Rusty Blackbird, Olive-sided Flycatcher and Bald Eagle (Figure 5, Figure 6, Table 4). The KIWDA has a slightly lower observation rate for species at risk (5.1%) as does the largest spatial scale KIWDA+150 km, where 14 species at risk were observed (4.33%) (Figure 5, Table 4).

Overall, the bird biodiversity information presented is based on data sources used to represent what birds have been observed in the Fawn River IPA, KIWDA and KIWDA+150 km (Table 2). Other resources exist that use scientific data and assumptions to predict the relationships between different bird species and their relationships to the land and water. For example, both eBird (eBird 2021) and the Boreal Avian Monitoring Project (BAM n.d.) have developed mathematical and statistical models to create distribution and range maps that could be applied to the Fawn River IPA, KIWDA and KIWDA+150 km (Appendix 3). These data and maps are publicly available for anyone to use and Fawn River IPA staff should consider obtaining these data for monitoring and research priorities.

Overall, the biodiversity and species found at all three spatial scales is relatively similar. Almost all species that were observed in the Fawn River IPA were also observed in the KIWDA, and/or KIWDA+150 km.

Bird nests in the Fawn River IPA, KIWDA and KIWDA + 150 km

Project NestWatch data were assessed to determine what nesting site information might be available for the Fawn River IPA, KIWDA and KIWDA+150 km. In contrast to the wealth of information associated with nesting in KI's Cultural Atlas, there is little or no scientific information or data on nesting areas in the Fawn River IPA and KIWDA.

Nineteen unique species' nest observations (n=40 observations) were identified in the Fawn River IPA based on Project NestWatch data (Appendix 5). These species included Canada Goose, Green-winged Teal, Bank Swallow and Bald Eagle as well as other forest birds and shorebirds. In the KIWDA, 28 species nests were observed (n = 58 observations) with two observations of Bald Eagle nests (Appendix 6). In the KIWDA+150 km, there were observations for 87 different species (n = 408 observations), including nests of Bald Eagles, Common Loons, Canada Geese and grouse species (Appendix 7).

In the Fawn River IPA and KIWDA, nests of species at risk were observed for two species: Bald Eagle and Bank Swallow. In KIWDA+150 km, nests for six more species were observed including Bald Eagle, Common Nighthawk, Olive-sided Flycatcher, Bank Swallow and Barn Swallow.

While scientific data are lacking on nesting habitats and locations of birds in this region, the available data suggests Bald Eagles, aerial insectivores like Bank Swallows and other species (forest birds and shorebirds in particular) nest in the Fawn River IPA and surrounding areas (Appendix 3).

Table 4. All bird species at risk found in the Fawn River IPA, KIWDA and KIWDA+150 km and their provincial and federal status based on species at risk legislation and designation processes.

Bird Species Name	Provincial Status*	Federal Status	Found in Fawn River IPA?	Found in KIWDA?	Found in KIWDA+150 km ?
American White Pelican	Threatened	Not At Risk	X	X	✓
Bald Eagle	Special Concern	Not At Risk	✓	✓	✓
Bank Swallow	Threatened	Threatened	✓	X	✓
Barn Swallow	Threatened	Threatened	X	X	✓
Black Tern	Special Concern	Not At Risk	X	X	✓
Canada Warbler	Special Concern	Threatened	X	X	✓
Common Nighthawk	Special Concern	Special Concern	✓	X	✓
Evening Grosbeak	Special Concern	Special Concern	X	X	✓
Golden Eagle	Endangered	Not At Risk	✓	X	✓
Horned Grebe	Special Concern	Special Concern	X	X	✓
Olive-sided Flycatcher	Special Concern	Special Concern	✓	✓	✓
Red-necked Phalarope	Special Concern	Special Concern	X	X	✓
Rusty Blackbird	Special Concern	Special Concern	✓	✓	✓
Short-eared Owl	Special Concern	Special Concern	X	X	✓

✓ = bird is present; x = bird is absent

* Note for the purposes of this atlas, the highest level of risk was used in describing bird status. For example, if the bird was designated as Special Concern at the provincial level and Not at Risk at the federal level, I classified the bird as Special Concern.

3. Benefits to people provided by Fawn River IPA birds

Bonaparte's Gull (Credit: Jeff Nadler)

Birds are important in their own right, but they also provide a number of services to humans that may be underappreciated. For example, birds act as a food source for many people (Şekercioğlu 2017), they regulate pests like insects and rodents by eating them (Whelan et al. 2008) and tens of thousands of plant species depend upon and benefit from seed dispersal by birds (Wenny et al. 2011). Overall, birds play a critical role in ecosystem functioning that in turn supports human well-being (Wenny et al. 2011, Sullivan 2012, Whelan et al. 2015, Şekercioğlu 2017) as well as supporting human economies (Whelan et al. 2015). In this section, I describe some of the ecosystem services provided by birds that are relevant to the Fawn River IPA.

Scavenging, or eating carcasses/carrion of mammals, fish and other species, is an important ecological service provided by birds. Turkey Vultures are the most common bird associated with scavenging and were observed in the KIWDA and KIWDA+150 km. Vulture stomachs are so acidic that bacteria, spores and toxins are destroyed, helping to reduce the spread of dis-


Common Raven (Credit: Jeff Nadler)

ease from carcasses to other animals, including humans (Wenny et al. 2011, Şekercioğlu 2017). Many other birds, including those found in and around the Fawn River IPA and KIWDA, are also important scavengers including birds of prey such as eagles or hawks, Common Ravens, gulls, herons, rails, shorebirds and even some woodpeckers (Wenny et al. 2011).

Scavenging also supports nutrient cycling that is critical for the functioning of many ecosystems, particularly in the north. Nutrient cycling refers to shifting nutrients (i.e. nitrogen, other elements) and cycling them into a different form or location so they can be used in processes throughout the ecosystem (Wenny et al. 2011). Nutrients are moved around a landscape as birds eat and move throughout the region.

Birds are important in their own right, but they also provide a number of services to humans that may be underappreciated.

Birds are important for seed dispersal (Wenny et al. 2011, Sullivan 2012, Whelan et al. 2015, Şekercioğlu 2017). Wenny et al. (2011) found that 33% of bird species disperse seeds, mainly through consumption and excretion with implications for the local plants as well as more broadly (e.g., nationally, internationally) (Sullivan 2012). Scientific studies summarized by Wenny et al. (2011) confirm that tens of thousands of plant species benefit from this ecological service because plants can grow in new places, escape plant predators, increase genetic diversity and contribute to better seed growth (Wenny et al. 2011). For example, geese, ducks and shorebirds, common in both the Fawn River IPA and KIWDA, can disperse plants within stream systems (Pollux et al. 2004). Birds like the Ruby-throated Hummingbird (Canadian Wildlife Federation 2022) found in the KIWDA+150 km area are important pollinators for flowering plants throughout the Canadian boreal region.

Birds are significant consumers of insects, some of which humans consider to be pests (Whelan et al. 2008, Wenny et al. 2011, Sullivan 2012, Whelan et al. 2015, Şekercioğlu 2017). Species found in the Fawn River IPA and KIWDA that consume insects include woodpeckers, warblers, ducks, swallows, nightjars, flycatchers and other birds. While this service is more obvious in agricultural landscapes (Whelan et al. 2008), it is likely important in the northern boreal region as well. For example, woodpeckers can control the outbreak of bark beetles in spruce species (Fayt et al. 2005); spruce is the most common species of tree in BCR 8 (EC 2014) and within the Fawn River IPA and surrounding areas. Birds have the potential to moderate the severity of insect outbreaks (Whelan et al. 2008). In addition, birds of prey eat rodents like mice that may also be considered pests by people. Given that climate change may alter species ranges including the potential for invasive forest species, this regulating ecological service of birds for insects and mice is important now and for the future in this region. Currently, it is estimated that boreal forest birds provide up to 5.4 billion dollars in pest control services (Berlanga et al. 2010).

Birds support other species by modifying the environment, particularly through nest-building. Woodpeckers, for example, create cavities in trees that are then used by many other species of birds, mammals and other creatures (Wenny et al. 2011). Through excavating nests or burrowing/digging/disrupting the ground (e.g. Bank Swallows excavating holes for nesting), birds also contribute to improving and maintaining soil function (Şekercioğlu 2017) and alter soil properties.

Birds affect ecological and social relationships at different scales. For example, the migratory bird species, which make up a majority of the bird species found in the Fawn River IPA and KIWDA, use a much larger spatial area as they migrate and overwinter annually. This means that their services benefit a far greater area at different times of the year (Whelan et al. 2008). Conserving birds and the full range of ecosystem services they provide within the Fawn River IPA and beyond is an important recommendation to support the continental responsibility to protect and ensure bird populations survival for future generations (FNSAP 2010).

Notably, 85.9% of the bird observations or 88 species in the Fawn River IPA did not fall within the cultural groupings of eagles, geese and ducks, grouse and loons (Figure 4, Table, 4, Appendix 4). The fact that a majority of species did not include culturally significant groups suggests that the scientific sampling for culturally important birds may be inadequate, as methodologies used focus on bird calls and/or songs (Table 2). This result also suggests that the bird biodiversity in this area is broader than culturally significant birds and that the Fawn River IPA provides important habitat to many species of birds of ecological and cultural importance, particularly forest and shrub birds and shorebirds. Many of the species observed in the Fawn River IPA and KIWDA are identified as priority species for bird conservation nationally (EC 2013, 2014, Appendix 8). Overall, community-based monitoring and research of both culturally and ecologically important groups of birds could be an important way to document the value and importance of birds in and around the Fawn River IPA and KIWDA.

Overall, community-based monitoring and research of both culturally and ecologically important groups of birds could be an important way to document the value and importance of birds in and around the Fawn River IPA and KIWDA.

4. Threats

Birds are resilient, diverse animals, but they are also vulnerable to human activities and their impacts on the environment. Over the past 48 years, it is estimated that roughly three billion breeding birds have died or disappeared. Using technologies such as radar, scientists have detected fewer and fewer birds as they study migration patterns (Rosenberg et al. 2019). Two hundred and sixty-nine million birds and two million nests are destroyed in Canada each year because of human activities that convert the land, including industrial activities (Calvert et al. 2013). Groups of birds found in the Fawn River IPA and KIWDA are currently in rapid decline. For example, Canada has lost 40-60% of the population numbers of shorebirds and aerial insectivores (including swallows and nighthawks) during the last five decades (NABCIC 2019). While human activities and development within northern areas including the Fawn River IPA is relatively low, it is important to develop research, monitoring and decision-support tools that can address human activities and climate change, and their impacts on birds to support proactive planning and protection (FNSAP 2010, EC 2013).

Climate change

An important threat impacting birds, particularly in northern regions, is climate change (EC 2013, EC 2014). Climate change threatens birds living in the Fawn River IPA and KIWDA (EC 2013, EC 2014). Climate change in northern Ontario includes warmer temperatures, more precipitation and rising sea levels (McDermid et al. 2015). This will result in shorter ice seasons, melting permafrost, and dynamic changes in lakes, streams, wildfires, species ranges and numbers (FNSAP 2010). Climate change is one of the foremost threats to the long-term maintenance of boreal wetlands with implications for boreal birds (Roach et al. 2011). For example, research in Manitoba documented how climate affects water depth, plant cover and food availability with negative population consequences for ducks and wetland birds (Baschuk et al. 2012).

The current and projected effects of climate change on bird species in these northern regions are relatively unknown (EC 2013, EC 2014). However, research shows that Arctic-breeding shorebirds' habitat and reproductive success are already impacted by climate change (Meltofte et al. 2007). There is a need for community-based monitoring and research to address how land use, particularly industrial development, together with climate change may interact affecting birds and other species.

Current and future land use

In general, industrial development poses a threat to bird species in many ways including: the removal of habitat, the degradation of habitat, the direct removal of birds through nest destruction, pesticide use and/or the indirect effects on birds through impacts on their prey (EC 2013). The Fawn River IPA and KIWDA are remote and have a limited industrial footprint including roads, mineral exploration and mining. While the human footprint, or land use, is currently limited, there is a potential of further development activities in the future. For example, the road proposals to the Ring of Fire are expected to have a growth-inducing effect (e.g., Johnson et al. 2019) that has implications for the broader region, including the Fawn River IPA and the bird species that use and depend on the area.

(Credit: Garth Lenz)

Forest cutting

More than 30% of Canada's boreal forest has been identified for economic development. Forests can also be removed and changed through mineral exploration, road building, mining and hydroelectric development (Boreal Songbird Initiative 2015). These activities and their direct and cumulative impacts on the forest are threats to birds in the Fawn River IPA (FNSAP 2010). Bird species respond differently to the effects of forest cutting and fragmentation created by clearcutting, roads and other linear features. Bird communities have been shown to be very different in boreal forests where open areas have been created by natural processes like fire compared to areas cut for timber (Hannon & Drapeau 2005).

Cutting intact boreal forest directly impacts birds by reducing the available interior forest habitat for birds that cannot or do not prefer to be near the edges of forest. For example, ovenbirds, which are found both in the Fawn River IPA and the KIWDA, rapidly decline following line cutting in old-growth forest (Machtans 2006). In some instances, forest harvest and the increased density of edges created by cutting, increased nest predation (Thompson et al. 2008). Forest fragmentation affects the ecosystem services that birds provide, particularly as seed disperser, since fragmented forest means fewer bird species will visit and use this area, resulting in low rates of plant recruitment (Cordeiro & Howe 2001).

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The removal of intact forest significantly increases birds' risks of extinction globally (Donald et al. 2018). Habitat degradation from development activities and forest removal can increase predation risk, decreasing the reproductive success of birds (EC 2013). The removal of forest within and around the Fawn River IPA and KIWDA has the potential to significantly change bird populations.

Pollution

Pollution is a major threat to birds in Canada. Chemicals, pesticides and development activities can introduce harmful substances into habitats that birds use affecting the quality of their habitat and prey, such as fish, insects and plants (Birds Canada 2022). Pollution can come from many sources affecting the ground, the water and the air. Development activities such as hydroelectric power generation and mining are significant threats to boreal wetlands and waters that birds depend upon (Cheskey et al. 2011). Birds in the Fawn River IPA and surrounding region require a diversity of habitats that may be impacted by pollution from development activities. Development activities damage and destroy habitats, reduce food availability and can expose birds to toxic compounds, including during migration (EC 2013). Cree youth have voiced their concerns about contaminants and pollution and how it might affect traditional foods including birds (Hlimi et al. 2012).

Pollution affects birds by causing starvation, increased predation and reductions in health and reproductive capacity through the accumulation of chemicals or toxins in body tissues, eggs and the blood (Cox 1991). Researchers have found migratory songbirds in Canada with high mercury levels from exposure on their breeding grounds (Ma et al. 2021). Mercury contamination in birds has also been linked to mining activities and road building, both directly (Brumbaugh et al. 2010) and indirectly through bioaccumulation (Weech et al. 2009). Common Loon, an important ecological and cultural species, has experienced population declines due to reductions in reproductive success in Ontario. A study found that water acidity and mercury levels were part of the causes of the decline (Bianchini et al. 2020). Baseline information on contaminant loads in the water, forests and birds is important to establish before development proceeds and should be monitored within the Fawn River IPA.

Interactive and cumulative effects

Many of the threats identified above can combine and interact with each other to produce cumulative effects that have greater impacts on birds and their habitats than their individual effects. Predicting the outcomes of combinations of land use and climate change is complex and challenging because cumulative effects occur across multiple time scales and spatial scales. However, scientists have conducted assessments of cumulative effects on birds to better understand their impacts. For example, Leston and colleagues (2020) studied how bird groups in Alberta might change in response to the cumulative effects of different patterns due to fire as well as land use through scenarios that considered the next 50 years. Similarly, Mahon and colleagues (2019) used statistical models to understand the implications of different levels of disturbance, from multiple land use trajectories (e.g., forestry, mining, energy) to model cumulative impacts and consider thresholds beyond which bird species were negatively impacted. In the United States, a common approach to considering cumulative effects on birds includes defining the total human footprint or disturbance on the land and assessing how tolerant species and species groups were to different levels of disturbance (Croonquist & Brooks 1992). In Canada, a study conducted on Treaty No. 8 in British Columbia modelled how the forests changed in response to increased industrial development, specifically increased fragmentation and removal of old growth (Nitschke 2008). Nitschke showed that the forest habitat(s) changed dramatically in response to cumulative development activities and that bird populations with different habitat requirements showed different responses. Overall, habitat was removed for many species while rates of nest parasitism and predation risk also increased (Nitschke 2008). Finally, Allen and O'Connor (2000) studied how the diversity and abundance of birds changed with human factors like development as well as natural disturbance.

In Canada, a study conducted on Treaty No. 8 in British Columbia modelled how the forests changed in response to increased industrial development, specifically increased fragmentation and removal of old growth.

Researchers associated with the Boreal Avian Monitoring Project (BAM n.d.) are considering large-scale, collaborative boreal cumulative effects projects while the regional assessment for the Ring of Fire[5] should also address cumulative effects on boreal and migratory birds.

Lack of scientific information

According to the Bird Conservation Strategies developed for BCR 7 and 8, with which the Fawn River IPA intersects, the biggest threat to bird species in these northern areas is a lack of scientific knowledge (EC 2013, EC 2014). For many species, there are gaps in the scientific knowledge and monitoring data for bird species and species at risk (EC 2013, EC 2014). At the same time, the effort per area for bird sampling datasets like the Ontario Breeding Bird Atlas (see Table 2) is lower compared to other regions in Ontario because of its remoteness and lack of road access (EC 2013, EC 2014).

One study found that monitoring efforts may not be enough to adequately observe birds of prey like owls and some hawk species in the boreal forest. Consequently, specialized monitoring efforts are needed for some bird populations (Kirk & Hyslop 1998). Abraham et al. (2011) also recommended more monitoring of migratory shorebirds, particularly during the spring and fall.

The lack of scientific data presents an opportunity for monitoring and research in the Fawn River IPA that considers "two-eyed seeing" (Reid et al. 2020), where Indigenous Knowledge Systems and expertise is considered alongside scientific knowledge to produce better, collaborative outcomes and decision making (Tsuji & Ho 2002, Reid et al. 2020). This approach could help fill knowledge gaps relevant to bird conservation and generate the best available information to support the value of the Fawn River IPA and region for birds and First Nations.

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5. Recommendations

The following recommendations draw on the analysis described in this section along with knowledge for similar regions to conserve bird species and the important roles they have in ecosystems and human communities in and around the Fawn River IPA. I also draw on recommendations established for the BCRs (EC 2013, EC 2014), the synthesis of research, status and trends of waterfowl in northern Ontario (Abraham 2014), and the recommendations and conservation strategies made by the Far North Science Advisory Panel (2010) and the 2019 *State of the Birds Report* (NABCIC 2019).

Create new knowledge

One of the main threats to this region is lack of scientific information since it limits understanding of the status of bird populations (i.e., declining, increasing, being stable) (EC 2013, EC 2014). There is existing Indigenous Knowledge, but it is important to co-create and/or share new knowledge to support learning, conservation and protection. Some ways this new knowledge can be co-created include working with KI on the following:

- **Participating in citizen/community science initiatives**
  Initiatives such as like the Breeding Bird Atlas (see Table 2) (currently underway for 2021-2025 period with more inclusion of First Nations), Project FeederWatch/NestWatch and using phone apps like eBird and iNaturalist to document and share information about what species of birds occur in the Fawn River IPA. Community-based research and monitoring can "provide some of the best knowledge of long-term bird population trends" (Berlanga et al. 2010).

- **Participating in complementary cultural and ecological monitoring/science**
  New knowledge can also be created through participation and collaboration with researchers and co-creating monitoring efforts in the Fawn River IPA. Community-based monitoring projects can include collaborations with academic, NGO or government scientists. The majority of the species found in the Fawn River and surrounding area did not fall within the cultural grouping defined by KI. Similarly, most of the bird data available were for species not found in the cultural groupings that KI identified in their Cultural Atlas. This result highlights a potential opportunity for improved monitoring of the Fawn River IPA for both culturally significant bird groups as well as other important groups like shorebirds and forest birds.

- **Improve bird monitoring**
  There are many gaps in bird monitoring, particularly for waterfowl (ducks and geese). Understanding these culturally and ecologically important species could be improved by increasing sea duck monitoring efforts, conducting helicopter aerial surveys, monitoring birds into the breeding season for late breeding species like scoters and mergansers, and conducting Indigenous harvest surveys with the community to document changes to these species over time (Abraham et al. 2014). Monitoring for aerial insectivores can also be improved by performing surveys at dawn and dusk since time of day affects detection rates of these species who are tracking insect-prey behaviours (Farrell et al. 2017, 2019).

Protect lands and waters

Creating ecologically meaningful protected areas of both cultural and ecological significance is important for intact regions in the ancestral homelands of many Indigenous communities.

Another main threat to birds, as discussed above, is habitat loss or degradation through potential development activities. One of the main ways to protect bird species is to protect their habitat (FSNAP 2010, EC 2013, EC 2014). Creating ecologically meaningful protected areas of both cultural and ecological significance is important for intact regions in the ancestral homelands of many Indigenous communities (FNSAP 2010). Protecting important bird habitat for bird groups is important for ensuring their conservation. Protecting wetlands, nesting habitats and forests is one of the ways to reduce losses of threatened species and support stable bird populations (NABCIC 2019).

- **Identify, monitor and map nesting and mating areas**
  Nesting habitats should be identified, monitored for use and productivity, and mapped over time for species that typically reuse nesting and mating areas (e.g., aerial insectivores, Sharp-tailed Grouse, Common Loon). These areas should be prioritized for protection as they will likely be used by many generations of birds.
- **Maintain involvement with IBA and KBA programs**
  Engage with biodiversity initiatives like the IBA and KBA programs in Ontario as one tool to bring international recognition to the Fawn River IPA and offer additional provincial incentive to recognize the Fawn River IPA and KI's governance.
- **Prioritize monitoring and research of species at risk**
  Protection of species at risk is mandated by provincial and federal laws and includes protection of their habitat. Community-based research and monitoring of species at risk offers opportunities to obtain funding and recognition for the Fawn River IPA and emphasize the importance of its species protection and recovery.

Monitor climatic and human-based changes to the landscape

Climate change is affecting species, ecosystems and ecosystem services. Monitoring the effects of climate change is critical for protected areas like the Fawn River IPA, which may be an important refuge for northern species (FSNAP 2010, EC 2013).

- **Develop community-based research and monitoring collaborations and include indicators of climate-change impacts on habitats and bird species**
  This monitoring can be done through community-based monitoring projects led by individual First Nations or by participation/support of research projects in and around the Fawn River IPA.
- **Increase awareness and understanding of cumulative effects, including climate change**
  Describing a future vision for the Fawn River IPA along with potential scenarios of change associated with land use and climate change and the impacts to bird species should be developed as part of the management plan for the Fawn River IPA.

Take Action

"Global environmental change and regional socio-economic threats mean that BCR 7 may face dramatic changes in the years to come" (EC 2013). Communities like KI remain at the forefront of conservation and protection on their homelands.

- **Pursue formal recognition of IPAs as protected lands**
  Promoting awareness of the importance of birds and their habitat is a conservation objective identified for the forested regions in BCR 8 (EC 2014). While KI has identified and worked to protect the Fawn River IPA under KI and Natural Laws, it must also be recognized by provincial and federal governments. Raising awareness about the need for government recognition as a formal protected area under KI's governance is needed.
- **Seek support and capacity to respond to projects that may affect birds in the Fawn River IPA**
  Governments have a duty to consult with KI while allies and other supporters can learn more about proposals that affect birds and the Fawn River IPA through the Environmental Registry of Ontario (Government of Ontario 2022).

Further information

[1] The *Migratory Birds Convention Act* (also MBCA) is a Canadian law established in 1917 and significantly updated in June 1994 which contains regulations to protect migratory birds, their eggs and their nests from destruction by wood harvesting, hunting, trafficking and commercialization. https://laws.justice.gc.ca/eng/acts/M-7.01/

[2] The PLC2000 consists of 27 broad land cover types and was produced in 2004 from an unsupervised classification of approximately 55 Landsat-7 ETM satellite images acquired between 1999 and 2002. https://geohub.lio.gov.on.ca/documents/lio::provincial-land-cover/about

[3] In 1999, the Canadian government, through its Minister of the Environment, recognized the North American Bird Conservation Initiative by signing a Commission for Environmental Cooperation Resolution. This resolution committed Canada, the United States and Mexico to create individual National Steering Committees to guide the initiative in each country.

[4] Key Biodiversity Areas of Canada. https://storymaps.arcgis.com/stories/8c578e05bd194e9bbf3bdca89172b47b (Accessed: May 12, 2022).

[5] The Regional Assessment will be conducted in the area centred on the Ring of Fire mineral deposits in northern Ontario, approximately 540 kilometres northeast of Thunder Bay and 1,000 kilometres north of Toronto and should consider multiple spatial scales and species including birds . More information can be found online at: https://iaac-aeic.gc.ca/050/evaluations/proj/80468

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7. Appendices

Appendix 1. Land cover classes and percent area (km^2) of the Fawn River IPA using Provincial Land Cover data (PLC2000).

Land Cover Type	Area (km^2)	Percent Area
Forest – sparse	4,008.1	30.8
Bog – treed	2,022.2	15.5
Water – deep clear	1,945.1	14.9
Bog – open	1,781.2	13.7
Fen – treed	754.0	5.8
Forest – regenerating depletion	638.8	4.9
Forest – dense coniferous	605.8	4.6
Forest – dense mixed	464.2	3.6
Forest depletion – burns	445.4	3.4
Fen – open	235.4	1.8
Other – unknown	102.4	0.8
Forest – dense deciduous	20.2	0.2
Settlement / infrastructure	4.1	0.0*
Sand / gravel / mine tailings	2.3	0.0*
TOTAL	**~13,025**	**100%**

* Area covered by land cover type is so small, that percent area is calculated at 0.0%.

Appendix 2. Land cover classes and percent area (km^2) of KIWDA using Provincial Land Cover data (PLC2000).

Land Cover Type	Area (km^2)	Percent Area
Forest – sparse	7,284.0	31.0
Water – deep clear	3,226.7	13.7
Bog – treed	2,978.1	12.7
Bog – open	2,734.2	11.6
Forest depletion – burns	1,516.9	6.5
Forest – dense coniferous	1,387.4	5.9
Fen – treed	1,380.1	5.9
Forest – regenerating depletion	1,332.7	5.7
Forest – dense mixed	1,234.7	5.3
Fen – open	152.6	0.6
Other – unknown	142.8	0.6
Forest – dense deciduous	40.6	0.2
Water – shallow / sedimented	39.6	0.2
None	38.1	0.2
Settlement / infrastructure	4.3	0.0*
Bedrock	1.4	0.0*
TOTAL	**~23,500**	**100%**

* Area covered by land cover type is so small that percent area is calculated at 0.0%.

Appendix 3. All bird species found in the Fawn River IPA, KIWDA and KIWDA +150 km.

Common Name	Scientific Name	Migratory Bird	Bird Group	Fawn River IPA	KIWDA	KIWDA+ 150 km
Bank Swallow	*Riparia riparia*	Y	Aerial Insectivores	Y	Y	Y
Barn Swallow	*Hirundo rustica*	Y	Aerial Insectivores	Y	Y	Y
Cliff Swallow	*Petrochelidon pyrrhonota*	Y	Aerial Insectivores	Y	Y	Y
Common Nighthawk	*Chordeiles minor*	Y	Aerial Insectivores	N	N	Y
Eastern Bluebird	*Sialia sialis*	Y	Aerial Insectivores	N	N	Y
Tree Swallow	*Tachycineta bicolor*	Y	Aerial Insectivores	Y	Y	Y
American Kestrel	*Falco sparverius*	Y	Birds of Prey	N	N	Y
Bald Eagle	*Haliaeetus leucocephalus*	N	Birds of Prey	Y	N	Y
Barred Owl	*Strix varia*	N	Birds of Prey	Y	Y	Y
Boreal Owl	*Aegolius funereus*	N	Birds of Prey	N	N	Y
Broad-winged Hawk	*Buteo platypterus*	Y	Birds of Prey	Y	Y	Y
Cooper's Hawk	*Accipiter cooperii*	Y	Birds of Prey	N	N	Y
falcon sp.	*NA*	N	Birds of Prey	Y	Y	Y
Great Gray Owl	*Strix nebulosa*	N	Birds of Prey	Y	Y	Y
Great Horned Owl	*Bubo virginianus*	N	Birds of Prey	N	N	Y
Long-eared Owl	*Asio otus*	Y	Birds of Prey	Y	Y	Y
Merlin	*Falco columbarius*	Y	Birds of Prey	N	N	Y
Northern Goshawk	*Accipiter gentilis*	N	Birds of Prey	N	N	Y
Northern Harrier	*Circus hudsonius*	Y	Birds of Prey	N	N	Y
Northern Hawk Owl	*Surnia ulula*	N	Birds of Prey	N	N	Y
Osprey	*Pandion haliaetus*	Y	Birds of Prey	Y	Y	Y
Red-tailed Hawk	*Buteo jamaicensis*	Y	Birds of Prey	N	N	Y
Rough-legged Hawk	*Buteo lagopus*	Y	Birds of Prey	Y	Y	Y
Sharp-shinned Hawk	*Accipiter striatus*	Y	Birds of Prey	Y	Y	Y
Short-eared Owl	*Asio flammeus*	Y	Birds of Prey	Y	N	Y
Golden Eagle	*Aquila chrysaetos*	Y	Eagles	Y	Y	Y

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Common Name	**Scientific Name**	**Migratory Bird**	**Bird Group**	**Fawn River IPA**	**KIWDA**	**KIWDA+ 150 km**
Alder Flycatcher	*Empidonax alnorum*	Y	Forest and Shrub Birds	Y	Y	Y
American Goldfinch	*Spinus tristis*	Y	Forest and Shrub Birds	N	N	Y
American Redstart	*Setophaga ruticilla*	Y	Forest and Shrub Birds	Y	N	Y
American Robin	*Turdus migratorius*	Y	Forest and Shrub Birds	N	N	Y
American Three-toed Woodpecker	*Picoides dorsalis*	N	Forest and Shrub Birds	Y	Y	Y
American Tree Sparrow	*Spizelloides arborea*	Y	Forest and Shrub Birds	Y	N	Y
Bay-breasted Warbler	*Setophaga castanea*	Y	Forest and Shrub Birds	Y	N	Y
Black-and-white Warbler	*Mniotilta varia*	Y	Forest and Shrub Birds	N	N	Y
Black-backed Woodpecker	*Picoides arcticus*	N	Forest and Shrub Birds	Y	N	Y
Blackburnian Warbler	*Setophaga fusca*	Y	Forest and Shrub Birds	N	N	Y
Black-capped Chickadee	*Poecile atricapillus*	N	Forest and Shrub Birds	N	N	Y
Blackpoll Warbler	*Setophaga striata*	Y	Forest and Shrub Birds	Y	N	Y
Black-throated Blue Warbler	*Setophaga caerulescens*	Y	Forest and Shrub Birds	Y	Y	Y
Black-throated Green Warbler	*Setophaga virens*	Y	Forest and Shrub Birds	Y	Y	Y
Blue Jay	*Cyanocitta cristata*	N	Forest and Shrub Birds	N	N	Y
Blue-headed Vireo	*Vireo solitarius*	Y	Forest and Shrub Birds	Y	Y	Y
Bohemian Waxwing	*Bombycilla garrulus*	Y	Forest and Shrub Birds	Y	Y	Y
Boreal Chickadee	*Poecile hudsonicus*	N	Forest and Shrub Birds	Y	N	Y
Brown Creeper	*Certhia americana*	Y	Forest and Shrub Birds	Y	N	Y
Brown Thrasher	*Toxostoma rufum*	Y	Forest and Shrub Birds	N	N	Y
Canada Jay	*Perisoreus canadensis*	N	Forest and Shrub Birds	N	N	Y
Canada Warbler	*Cardellina canadensis*	Y	Forest and Shrub Birds	N	N	Y
Cape May Warbler	*Setophaga tigrina*	Y	Forest and Shrub Birds	Y	Y	Y
Cedar Waxwing	*Bombycilla cedrorum*	Y	Forest and Shrub Birds	N	N	Y
Chestnut-sided Warbler	*Setophaga pensylvanica*	Y	Forest and Shrub Birds	N	N	Y
Chipping Sparrow	*Spizella passerina*	Y	Forest and Shrub Birds	Y	Y	Y

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Common Name	Scientific Name	Migratory Bird	Bird Group	Fawn River IPA	KIWDA	KIWDA+ 150 km
Clay-colored Sparrow	*Spizella pallida*	Y	Forest and Shrub Birds	N	N	Y
Common Grackle	*Quiscalus quiscula*	Y	Forest and Shrub Birds	N	N	Y
Common Redpoll	*Acanthis flammea*	Y	Forest and Shrub Birds	N	N	Y
Common Yellowthroat	*Geothlypis trichas*	Y	Forest and Shrub Birds	Y	Y	Y
Common/Hoary Redpoll	*NA*	Y	Forest and Shrub Birds	N	N	Y
Connecticut Warbler	*Oporornis agilis*	Y	Forest and Shrub Birds	Y	Y	Y
Dark-eyed Junco	*Junco hyemalis*	Y	Forest and Shrub Birds	Y	Y	Y
Downy Woodpecker	*Dryobates pubescens*	N	Forest and Shrub Birds	N	N	Y
Eastern Phoebe	*Sayornis phoebe*	Y	Forest and Shrub Birds	Y	Y	Y
Empidonax sp.	*NA*	N	Forest and Shrub Birds	Y	Y	Y
European Starling	*Sturnus vulgaris*	N	Forest and Shrub Birds	Y	N	Y
Evening Grosbeak	*Coccothraustes vespertinus*	N	Forest and Shrub Birds	N	N	Y
Fox Sparrow	*Passerella iliaca*	Y	Forest and Shrub Birds	N	N	Y
Golden-crowned Kinglet	*Regulus satrapa*	Y	Forest and Shrub Birds	Y	N	Y
Gray Catbird	*Dumetella carolinensis*	Y	Forest and Shrub Birds	Y	Y	Y
Gray Jay	*see Canada Jay*	N	Forest and Shrub Birds	N	N	Y
Gray-cheeked Thrush	*Catharus minimus*	Y	Forest and Shrub Birds	N	N	Y
Great Crested Flycatcher	*Myiarchus crinitus*	Y	Forest and Shrub Birds	N	N	Y
Hairy Woodpecker	*Dryobates villosus*	N	Forest and Shrub Birds	Y	Y	Y
Harris's Sparrow	*Zonotrichia querula*	Y	Forest and Shrub Birds	Y	Y	Y
Hermit Thrush	*Catharus guttatus*	Y	Forest and Shrub Birds	Y	Y	Y
Hoary Redpoll	*Acanthis hornemanni*	Y	Forest and Shrub Birds	N	N	Y
House Finch	*Haemorhous mexicanus*	N	Forest and Shrub Birds	N	N	Y
House Sparrow	*Passer domesticus*	N	Forest and Shrub Birds	N	N	Y
Least Flycatcher	*Empidonax minimus*	Y	Forest and Shrub Birds	Y	Y	Y
LeConte's Sparrow	*Ammospiza leconteii*	Y	Forest and Shrub Birds	N	N	Y

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Common Name	Scientific Name	Migratory Bird	Bird Group	Fawn River IPA	KIWDA	KIWDA+ 150 km
Lincoln's Sparrow	*Melospiza lincolnii*	Y	Forest and Shrub Birds	Y	Y	Y
Magnolia Warbler	*Setophaga magnolia*	Y	Forest and Shrub Birds	N	N	Y
Mourning Dove	*Zenaida macroura*	Y	Forest and Shrub Birds	Y	Y	Y
Mourning Warbler	*Geothlypis philadelphia*	Y	Forest and Shrub Birds	Y	Y	Y
Nashville Warbler	*Leiothlypis ruficapilla*	Y	Forest and Shrub Birds	Y	Y	Y
Northern Cardinal	*Cardinalis cardinalis*	N	Forest and Shrub Birds	N	N	Y
Northern Flicker	*Colaptes auratus*	Y	Forest and Shrub Birds	N	N	Y
Northern Parula	*Setophaga americana*	Y	Forest and Shrub Birds	Y	Y	Y
Northern Shrike	*Lanius borealis*	Y	Forest and Shrub Birds	N	Y	Y
Northern Waterthrush	*Parkesia noveboracensis*	Y	Forest and Shrub Birds	Y	N	Y
Olive-sided Flycatcher	*Contopus cooperi*	Y	Forest and Shrub Birds	N	N	Y
Orange-crowned Warbler	*Leiothlypis celata*	Y	Forest and Shrub Birds	N	N	Y
Ovenbird	*Seiurus aurocapilla*	Y	Forest and Shrub Birds	N	N	Y
Palm Warbler	*Setophaga palmarum*	Y	Forest and Shrub Birds	Y	Y	Y
Philadelphia Vireo	*Vireo philadelphicus*	Y	Forest and Shrub Birds	Y	Y	Y
Pileated Woodpecker	*Dryocopus pileatus*	N	Forest and Shrub Birds	Y	Y	Y
Pine Grosbeak	*Pinicola enucleator*	N	Forest and Shrub Birds	N	N	Y
Pine Siskin	*Spinus pinus*	Y	Forest and Shrub Birds	N	N	Y
Purple Finch	*Haemorhous purpureus*	Y	Forest and Shrub Birds	N	N	Y
Red Crossbill	*Loxia curvirostra*	N	Forest and Shrub Birds	Y	Y	Y
Red-bellied Woodpecker	*Melanerpes carolinus*	N	Forest and Shrub Birds	N	N	Y
Red-breasted Nuthatch	*Sitta canadensis*	N	Forest and Shrub Birds	Y	Y	Y
Red-eyed Vireo	*Vireo olivaceus*	Y	Forest and Shrub Birds	N	N	Y
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Y	Forest and Shrub Birds	N	N	Y
Ruby-crowned Kinglet	*Regulus calendula*	Y	Forest and Shrub Birds	N	N	Y
Ruby-throated Hummingbird	*Archilochus colubris*	Y	Forest and Shrub Birds	N	N	Y

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Common Name	Scientific Name	Migratory Bird	Bird Group	Fawn River IPA	KIWDA	KIWDA+ 150 km
Rusty Blackbird	*Euphagus carolinus*	Y	Forest and Shrub Birds	Y	Y	Y
Song Sparrow	*Melospiza melodia*	Y	Forest and Shrub Birds	Y	Y	Y
sparrow sp.	*NA*	N	Forest and Shrub Birds	Y	Y	Y
Swainson's Thrush	*Catharus ustulatus*	Y	Forest and Shrub Birds	N	N	Y
Tennessee Warbler	*Leiothlypis peregrina*	Y	Forest and Shrub Birds	N	N	Y
Three-toed Woodpecker		N	Forest and Shrub Birds	Y	Y	Y
thrush sp.	*NA*	N	Forest and Shrub Birds	Y	Y	Y
Tufted Titmouse	*Baeolophus bicolor*	N	Forest and Shrub Birds	Y	N	Y
Veery	*Catharus fuscescens*	Y	Forest and Shrub Birds	Y	Y	Y
vireo sp.	*NA*	N	Forest and Shrub Birds	Y	Y	Y
White-breasted Nuthatch	*Sitta carolinensis*	N	Forest and Shrub Birds	Y	Y	Y
White-crowned Sparrow	*Zonotrichia leucophrys*	Y	Forest and Shrub Birds	Y	Y	Y
White-throated Sparrow	*Zonotrichia albicollis*	Y	Forest and Shrub Birds	Y	Y	Y
White-winged Crossbill	*Loxia leucoptera*	N	Forest and Shrub Birds	N	N	Y
Wilson's Warbler	*Cardellina pusilla*	Y	Forest and Shrub Birds	Y	Y	Y
Winter Wren	*Troglodytes hiemalis*	Y	Forest and Shrub Birds	Y	Y	Y
woodpecker sp.	*NA*	N	Forest and Shrub Birds	Y	Y	Y
Yellow Warbler	*Setophaga petechia*	Y	Forest and Shrub Birds	Y	Y	Y
Yellow-bellied Flycatcher	*Empidonax flaviventris*	Y	Forest and Shrub Birds	Y	Y	Y
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Y	Forest and Shrub Birds	N	N	Y
Yellow-rumped Warbler	*Setophaga coronata*	Y	Forest and Shrub Birds	Y	Y	Y
American Black Duck	*Anas rubripes*	Y	Geese and Ducks	N	N	Y
American Wigeon	*Mareca americana*	Y	Geese and Ducks	Y	Y	Y
Black Scoter	*Melanitta americana*	Y	Geese and Ducks	N	N	Y
Blue-winged Teal	*Spatula discors*	Y	Geese and Ducks	Y	Y	Y
Bufflehead	*Bucephala albeola*	Y	Geese and Ducks	Y	Y	Y

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Common Name	Scientific Name	Migratory Bird	Bird Group	Fawn River IPA	KIWDA	KIWDA+ 150 km
Canada Goose	*Branta canadensis*	Y	Geese and Ducks	Y	Y	Y
Canada Goose	*see Canada Goose*	Y	Geese and Ducks	N	N	Y
Common Goldeneye	*Bucephala clangula*	Y	Geese and Ducks	Y	Y	Y
Common Merganser	*Mergus merganser*	Y	Geese and Ducks	Y	Y	Y
duck sp.	*NA*	N	Geese and Ducks	N	N	Y
Gadwall	*Mareca strepera*	Y	Geese and Ducks	Y	Y	Y
Greater Scaup	*Aythya marila*	Y	Geese and Ducks	Y	N	Y
Greater/Lesser Scaup	*NA*	Y	Geese and Ducks	N	N	Y
Green-winged Teal	*Anas crecca*	Y	Geese and Ducks	Y	Y	Y
Hooded Merganser	*Lophodytes cucullatus*	Y	Geese and Ducks	N	N	Y
Horned Grebe	*Podiceps auritus*	Y	Geese and Ducks	Y	Y	Y
Lesser Scaup	*Aythya affinis*	Y	Geese and Ducks	N	N	Y
Mallard	*Anas platyrhynchos*	Y	Geese and Ducks	N	N	Y
Northern Pintail	*Anas acuta*	Y	Geese and Ducks	N	N	Y
Northern Shoveler	*Spatula clypeata*	Y	Geese and Ducks	Y	Y	Y
Pied-billed Grebe	*Podilymbus podiceps*	Y	Geese and Ducks	Y	Y	Y
Red-breasted Merganser	*Mergus serrator*	Y	Geese and Ducks	Y	Y	Y
Red-necked Grebe	*Podiceps grisegena*	Y	Geese and Ducks	Y	Y	Y
Ring-necked Duck	*Aythya collaris*	Y	Geese and Ducks	N	N	Y
Surf Scoter	*Melanitta perspicillata*	Y	Geese and Ducks	N	N	Y
White-winged Scoter	*Melanitta deglandi*	Y	Geese and Ducks	N	N	Y
Wood Duck	*Aix sponsa*	Y	Geese and Ducks	Y	Y	Y
American Pipit	*Anthus rubescens*	Y	Grassland and Tundra Birds	Y	N	Y
Brown-headed Cowbird	*Molothrus ater*	Y	Grassland and Tundra Birds	Y	Y	Y
Eastern Kingbird	*Tyrannus tyrannus*	Y	Grassland and Tundra Birds	Y	Y	Y
Killdeer	*Charadrius vociferus*	Y	Grassland and Tundra Birds	N	Y	Y
Lapland Longspur	*Calcarius lapponicus*	Y	Grassland and Tundra Birds	Y	Y	Y

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Common Name	Scientific Name	Migratory Bird	Bird Group	Fawn River IPA	KIWDA	KIWDA+ 150 km
Le Conte's Sparrow	*see LeConte's Sparrow*	Y	Grassland and Tundra Birds	N	N	Y
McCown's Longspur	*Rhynchophanes mccownii*	Y	Grassland and Tundra Birds	N	N	Y
Savannah Sparrow	*Passerculus sandwichensis*	Y	Grassland and Tundra Birds	N	N	Y
Snow Bunting	*Plectrophenax nivalis*	Y	Grassland and Tundra Birds	N	N	Y
Vesper Sparrow	*Pooecetes gramineus*	Y	Grassland and Tundra Birds	Y	Y	Y
Ruffed Grouse	*Bonasa umbellus*	N	Grouse and Grouse-like Birds	Y	Y	Y
Sharp-tailed Grouse	*Tympanuchus phasianellus*	N	Grouse and Grouse-like Birds	N	N	Y
Spruce Grouse	*Falcipennis canadensis*	N	Grouse and Grouse-like Birds	N	N	Y
Willow Ptarmigan	*Lagopus lagopus*	N	Grouse and Grouse-like Birds	N	N	Y
Common Loon	*Gavia immer*	Y	Loons	Y	Y	Y
Red-throated Loon	*Gavia stellata*	Y	Loons	Y	Y	Y
American Crow	*Corvus brachyrhynchos*	N	Scavengers	Y	Y	Y
Common Raven	*Corvus corax*	N	Scavengers	N	N	Y
Turkey Vulture	*Cathartes aura*	Y	Scavengers	Y	Y	Y
American Golden-Plover	*Pluvialis dominica*	Y	Shorebirds, Gulls and Terns	Y	N	Y
Arctic Tern	*Sterna paradisaea*	Y	Shorebirds, Gulls and Terns	Y	N	Y
Baird's Sandpiper	*Calidris bairdii*	Y	Shorebirds, Gulls and Terns	Y	Y	Y
Black Tern	*Chlidonias niger*	Y	Shorebirds, Gulls and Terns	Y	Y	Y
Black-bellied Plover	*Pluvialis squatarola*	Y	Shorebirds, Gulls and Terns	Y	Y	Y
Bonaparte's Gull	*Chroicocephalus philadelphia*	Y	Shorebirds, Gulls and Terns	Y	Y	Y
Caspian Tern	*Hydroprogne caspia*	Y	Shorebirds, Gulls and Terns	N	N	Y
Common Tern	*Sterna hirundo*	Y	Shorebirds, Gulls and Terns	N	N	Y
Greater Yellowlegs	*Tringa melanoleuca*	Y	Shorebirds, Gulls and Terns	Y	Y	Y
Greater/Lesser Yellowlegs	*NA*	Y	Shorebirds, Gulls and Terns	N	N	Y
gull sp.	*NA*	N	Shorebirds, Gulls and Terns	Y	Y	Y
Herring Gull	*Larus argentatus*	Y	Shorebirds, Gulls and Terns	N	N	Y
Hudsonian Godwit	*Limosa haemastica*	Y	Shorebirds, Gulls and Terns	N	N	Y
Ivory Gull	*Pagophila eburnea*	Y	Shorebirds, Gulls and Terns	N	N	Y

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Common Name	Scientific Name	Migratory Bird	Bird Group	Fawn River IPA	KIWDA	KIWDA+ 150 km
Larus sp.	*NA*	N	Shorebirds, Gulls and Terns	Y	N	Y
Least Sandpiper	*Calidris minutilla*	Y	Shorebirds, Gulls and Terns	N	N	Y
Lesser Yellowlegs	*Tringa flavipes*	Y	Shorebirds, Gulls and Terns	N	N	Y
Little Gull	*Hydrocoloeus minutus*	Y	Shorebirds, Gulls and Terns	N	N	Y
Red-necked Phalarope	*Phalaropus lobatus*	Y	Shorebirds, Gulls and Terns	N	N	Y
Ring-billed Gull	*Larus delawarensis*	Y	Shorebirds, Gulls and Terns	N	N	Y
Ruddy Turnstone	*Arenaria interpres*	Y	Shorebirds, Gulls and Terns	N	N	Y
Semipalmated Plover	*Charadrius semipalmatus*	Y	Shorebirds, Gulls and Terns	N	N	Y
Semipalmated Sandpiper	*Calidris pusilla*	Y	Shorebirds, Gulls and Terns	Y	N	Y
shorebird sp.	*NA*	N	Shorebirds, Gulls and Terns	Y	Y	Y
Short-billed Dowitcher	*Limnodromus griseus*	Y	Shorebirds, Gulls and Terns	Y	Y	Y
Solitary Sandpiper	*Tringa solitaria*	Y	Shorebirds, Gulls and Terns	N	N	Y
Spotted Sandpiper	*Actitis macularius*	Y	Shorebirds, Gulls and Terns	N	N	Y
Whimbrel	*Numenius phaeopus*	Y	Shorebirds, Gulls and Terns	N	Y	Y
American Bittern	*Botaurus lentiginosus*	Y	Wetland and Water Birds	Y	Y	Y
American White Pelican	*Pelecanus erythrorhynchos*	Y	Wetland and Water Birds	N	N	Y
Belted Kingfisher	*Megaceryle alcyon*	Y	Wetland and Water Birds	Y	N	Y
Common Snipe	*Gallinago gallinago*	Y	Wetland and Water Birds	N	N	Y
Double-crested Cormorant	*Phalacrocorax auritus*	Y	Wetland and Water Birds	Y	Y	Y
Great Blue Heron	*Ardea herodias*	Y	Wetland and Water Birds	Y	N	Y
Red-winged Blackbird	*Agelaius phoeniceus*	Y	Wetland and Water Birds	Y	Y	Y
Sandhill Crane	*Antigone canadensis*	Y	Wetland and Water Birds	N	N	Y
Sora	*Porzana carolina*	Y	Wetland and Water Birds	Y	Y	Y
Swamp Sparrow	*Melospiza georgiana*	Y	Wetland and Water Birds	N	N	Y
Trumpeter Swan	*Cygnus buccinator*	Y	Wetland and Water Birds	Y	Y	Y
Trumpeter/Tundra Swan	*NA*	Y	Wetland and Water Birds	N	N	Y
Tundra Swan	*Cygnus columbianus*	Y	Wetland and Water Birds	Y	Y	Y
Virginia Rail	*Rallus limicola*	Y	Wetland and Water Birds	N	N	Y
Wilson's Snipe	*Gallinago delicata*	Y	Wetland and Water Birds	N	N	Y

Appendix 4. Number of observations and percent proportion of cultural/ecological bird groups in Fawn River IPA, KIWDA and KIWDA+150 km.

Spatial Scale	Bird Group	Number of Observations	Total Observations for Spatial Scale	Percent of Observations	Number of Species
Fawn River IPA	Aerial Insectivores	13	989	1.3	3
Fawn River IPA	Birds of Prey	16	989	1.6	7
Fawn River IPA	Eagles	33	989	3.3	2
Fawn River IPA	Forest and Shrub Birds	655	989	66.2	53
Fawn River IPA	Geese and Ducks	81	989	8.2	14
Fawn River IPA	Grassland and Tundra Birds	11	989	1.1	3
Fawn River IPA	Grouse and Grouse-like Birds	9	989	0.9	4
Fawn River IPA	Loons	16	989	1.6	1
Fawn River IPA	Scavengers	38	989	3.8	2
Fawn River IPA	Shorebirds, Gulls and Terns	77	989	7.8	12
Fawn River IPA	Wetland and Water Birds	40	989	4	7
KIWDA	Aerial Insectivores	5	711	0.7	1
KIWDA	Birds of Prey	10	711	1.4	6
KIWDA	Eagles	19	711	2.7	1
KIWDA	Forest and Shrub Birds	495	711	69.6	50
KIWDA	Geese and Ducks	46	711	6.5	11
KIWDA	Grassland and Tundra Birds	9	711	1.3	2
KIWDA	Grouse and Grouse-like Birds	6	711	0.8	2
KIWDA	Loons	14	711	2	1
KIWDA	Scavengers	33	711	4.6	2
KIWDA	Shorebirds, Gulls and Terns	43	711	6	9
KIWDA	Wetland and Water Birds	31	711	4.4	6

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Spatial Scale	Bird Group	Number of Observations	Total Observations for Spatial Scale	Percent of Observations	Number of Species
KIWDA+150 km	Aerial Insectivores	293	16,754	1.7	6
KIWDA+150 km	Birds of Prey	352	16,754	2.1	17
KIWDA+150 km	Eagles	304	16,754	1.8	2
KIWDA+150 km	Forest and Shrub Birds	12,099	16,754	72.2	91
KIWDA+150 km	Geese and Ducks	845	16,754	5	24
KIWDA+150 km	Grassland and Tundra Birds	198	16,754	1.2	9
KIWDA+150 km	Grouse and Grouse-like Birds	166	16,754	1	4
KIWDA+150 km	Loons	251	16,754	1.5	2
KIWDA+150 km	Scavengers	435	16,754	2.6	3
KIWDA+150 km	Shorebirds, Gulls and Terns	1176	16,754	7	24
KIWDA+150 km	Wetland and Water Birds	635	16,754	3.8	14

Appendix 5. Nest observations from Project NestWatch in the Fawn River IPA area.

Common Name	Scientific Name	Number of Observations	Migrating Bird?	Bird Group
Bald Eagle	*Haliaeetus leucocephalus*	2	N	Eagles
Bank Swallow	*Riparia riparia*	3	Y	Aerial Insectivores
Blackpoll Warbler	*Setophaga striata*	2	Y	Forest and Shrub Birds
Blue-headed Vireo	*Vireo solitarius*	1	Y	Forest and Shrub Birds
Canada Goose	*Branta canadensis*	1	Y	Geese and Ducks
Chipping Sparrow	*Spizella passerina*	3	Y	Forest and Shrub Birds
Cliff Swallow	*Petrochelidon pyrrhonota*	1	Y	Aerial Insectivores
Dark-eyed Junco	*Junco hyemalis*	1	Y	Forest and Shrub Birds
Eastern Phoebe	*Sayornis phoebe*	4	Y	Forest and Shrub Birds
European Starling	*Sturnus vulgaris*	3	N	Forest and Shrub Birds
Green-winged Teal	*Anas crecca*	1	Y	Geese and Ducks
Killdeer	*Charadrius vociferus*	1	Y	Grassland and Tundra Birds
Northern Flicker	*Colaptes auratus*	1	Y	Forest and Shrub Birds
Osprey	*Pandion haliaetus*	1	Y	Birds of Prey
Palm Warbler	*Setophaga palmarum*	1	Y	Forest and Shrub Birds
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	2	Y	Forest and Shrub Birds
Semipalmated Plover	*Charadrius semipalmatus*	5	Y	Shorebirds, Gulls and Terns
Spotted Sandpiper	*Actitis macularius*	5	Y	Shorebirds, Gulls and Terns
Veery	*Catharus fuscescens*	2	Y	Forest and Shrub Birds

Appendix 6. Nest observations from Project NestWatch in the KIWDA.

Common Name	Scientific Name	Number of Observations	Migrating Bird?	Bird Group
American Robin	*Turdus migratorius*	2	Y	Forest and Shrub Birds
Arctic Tern	*Sterna paradisaea*	1	Y	Shorebirds, Gulls and Terns
Bald Eagle	*Haliaeetus leucocephalus*	2	N	Eagles
Bank Swallow	*Riparia riparia*	3	Y	Aerial Insectivores
Belted Kingfisher	*Megaceryle alcyon*	1	Y	Wetland and Water Birds
Blue-headed Vireo	*Vireo solitaries*	1	Y	Forest and Shrub Birds
Chipping Sparrow	*Spizella passerine*	3	Y	Forest and Shrub Birds
Cliff Swallow	*Petrochelidon pyrrhonota*	1	Y	Aerial Insectivores
Dark-eyed Junco	*Junco hyemalis*	1	Y	Forest and Shrub Birds
Eastern Phoebe	*Sayornis phoebe*	4	Y	Forest and Shrub Birds
European Starling	*Sturnus vulgaris*	3	N	Forest and Shrub Birds
Great Horned Owl	*Bubo virginianus*	1	N	Birds of Prey
Green-winged Teal	*Anas crecca*	1	Y	Geese and Ducks
Killdeer	*Charadrius vociferus*	1	Y	Grassland and Tundra Birds
Northern Flicker	*Colaptes auratus*	1	Y	Forest and Shrub Birds
Northern Waterthrush	*Parkesia noveboracensis*	2	Y	Forest and Shrub Birds
Osprey	*Pandion haliaetus*	1	Y	Birds of Prey
Palm Warbler	*Setophaga palmarum*	1	Y	Forest and Shrub Birds
Red-eyed Vireo	*Vireo olivaceus*	6	Y	Forest and Shrub Birds
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	2	Y	Forest and Shrub Birds
Savannah Sparrow	*Passerculus sandwichensis*	2	Y	Grassland and Tundra Birds
Semipalmated Plover	*Charadrius semipalmatus*	6	Y	Shorebirds, Gulls and Terns
Spotted Sandpiper	*Actitis macularius*	5	Y	Shorebirds, Gulls and Terns
Swainson's Thrush	*Catharus ustulatus*	1	Y	Forest and Shrub Birds
Tennessee Warbler	*Leiothlypis peregrina*	1	Y	Forest and Shrub Birds
Veery	*Catharus fuscescens*	2	Y	Forest and Shrub Birds
White-throated Sparrow	*Zonotrichia albicollis*	1	Y	Forest and Shrub Birds
Yellow Warbler	*Setophaga petechia*	2	Y	Forest and Shrub Birds

Appendix 7. Nest observations from Project NestWatch in KIWDA+150 km.

Common Name	Scientific Name	Number of Observations	Migrating Bird?	Bird Group
Alder Flycatcher	*Empidonax alnorum*	2	Y	Forest and Shrub Birds
American Crow	*Corvus brachyrhynchos*	1	N	Scavengers
American Kestrel	*Falco sparverius*	1	Y	Birds of Prey
American Robin	*Turdus migratorius*	3	Y	Forest and Shrub Birds
American Three-toed Woodpecker	*Picoides dorsalis*	1	N	Forest and Shrub Birds
Arctic Tern	*Sterna paradisaea*	1	Y	Shorebirds, Gulls and Terns
Bald Eagle	*Haliaeetus leucocephalus*	145	N	Eagles
Bank Swallow	*Riparia riparia*	4	Y	Aerial Insectivores
Barn Swallow	*Hirundo rustica*	1	Y	Aerial Insectivores
Bay-breasted Warbler	*Setophaga castanea*	1	Y	Forest and Shrub Birds
Belted Kingfisher	*Megaceryle alcyon*	10	Y	Wetland and Water Birds
Black-backed Woodpecker	*Picoides arcticus*	2	N	Forest and Shrub Birds
Blackpoll Warbler	*Setophaga striata*	2	Y	Forest and Shrub Birds
Blue-headed Vireo	*Vireo solitarius*	2	Y	Forest and Shrub Birds
Blue-winged Teal	*Spatula discors*	1	Y	Geese and Ducks
Boreal Chickadee	*Poecile hudsonicus*	3	N	Forest and Shrub Birds
Brown Creeper	*Certhia americana*	1	Y	Forest and Shrub Birds
Canada Goose	*Branta canadensis*	1	Y	Geese and Ducks
Canada Jay	*Perisoreus canadensis*	1	N	Forest and Shrub Birds
Cedar Waxwing	*Bombycilla cedrorum*	2	Y	Forest and Shrub Birds
Chipping Sparrow	*Spizella passerina*	7	Y	Forest and Shrub Birds
Cliff Swallow	*Petrochelidon pyrrhonota*	3	Y	Aerial Insectivores
Common Grackle	*Quiscalus quiscula*	1	Y	Forest and Shrub Birds
Common Loon	*Gavia immer*	5	Y	Loons
Common Merganser	*Mergus merganser*	3	Y	Geese and Ducks
Common Nighthawk	*Chordeiles minor*	3	Y	Aerial Insectivores
Common Raven	*Corvus corax*	16	N	Scavengers
Common Tern	*Sterna hirundo*	6	Y	Shorebirds, Gulls and Terns

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Common Name	**Scientific Name**	**Number of Observations**	**Migrating Bird?**	**Bird Group**
Dark-eyed Junco	*Junco hyemalis*	4	Y	Forest and Shrub Birds
Double-crested Cormorant	*Phalacrocorax auritus*	1	Y	Wetland and Water Birds
Eastern Phoebe	*Sayornis phoebe*	4	Y	Forest and Shrub Birds
European Starling	*Sturnus vulgaris*	3	N	Forest and Shrub Birds
Fox Sparrow	*Passerella iliaca*	2	Y	Forest and Shrub Birds
Great Blue Heron	*Ardea herodias*	1	Y	Wetland and Water Birds
Great Horned Owl	*Bubo virginianus*	1	N	Birds of Prey
Greater Yellowlegs	*Tringa melanoleuca*	1	Y	Shorebirds, Gulls and Terns
Green-winged Teal	*Anas crecca*	1	Y	Geese and Ducks
Hairy Woodpecker	*Dryobates villosus*	2	N	Forest and Shrub Birds
Hermit Thrush	*Catharus guttatus*	1	Y	Forest and Shrub Birds
Herring Gull	*Larus argentatus*	16	Y	Shorebirds, Gulls and Terns
Killdeer	*Charadrius vociferus*	2	Y	Grassland and Tundra Birds
Least Flycatcher	*Empidonax minimus*	2	Y	Forest and Shrub Birds
Lesser Scaup	*Aythya affinis*	1	Y	Geese and Ducks
Lesser Yellowlegs	*Tringa flavipes*	1	Y	Shorebirds, Gulls and Terns
Mallard	*Anas platyrhynchos*	3	Y	Geese and Ducks
Mourning Dove	*Zenaida macroura*	2	Y	Forest and Shrub Birds
Northern Flicker	*Colaptes auratus*	12	Y	Forest and Shrub Birds
Northern Waterthrush	*Parkesia noveboracensis*	2	Y	Forest and Shrub Birds
Olive-sided Flycatcher	*Contopus cooperi*	1	Y	Forest and Shrub Birds
Orange-crowned Warbler	*Leiothlypis celata*	1	Y	Forest and Shrub Birds
Osprey	*Pandion haliaetus*	20	Y	Birds of Prey
Palm Warbler	*Setophaga palmarum*	4	Y	Forest and Shrub Birds
Red-breasted Merganser	*Mergus serrator*	1	Y	Geese and Ducks
Red-eyed Vireo	*Vireo olivaceus*	10	Y	Forest and Shrub Birds
Red-necked Grebe	*Podiceps grisegena*	1	Y	Geese and Ducks
Red-tailed Hawk	*Buteo jamaicensis*	1	Y	Birds of Prey

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Common Name	Scientific Name	Number of Observations	Migrating Bird?	Bird Group
Red-winged Blackbird	*Agelaius phoeniceus*	3	Y	Wetland and Water Birds
Ring-necked Duck	*Aythya collaris*	1	Y	Geese and Ducks
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	4	Y	Forest and Shrub Birds
Ruffed Grouse	*Bonasa umbellus*	1	N	Grouse and Grouse-like Birds
Savannah Sparrow	*Passerculus sandwichensis*	2	Y	Grassland and Tundra Birds
Semipalmated Plover	*Charadrius semipalmatus*	8	Y	Shorebirds, Gulls and Terns
Song Sparrow	*Melospiza melodia*	2	Y	Forest and Shrub Birds
Sora	*Porzana carolina*	1	Y	Wetland and Water Birds
Spotted Sandpiper	*Actitis macularius*	18	Y	Shorebirds, Gulls and Terns
Spruce Grouse	*Falcipennis canadensis*	1	N	Grouse and Grouse-like Birds
Swainson's Thrush	*Catharus ustulatus*	1	Y	Forest and Shrub Birds
Swamp Sparrow	*Melospiza georgiana*	1	Y	Wetland and Water Birds
Tennessee Warbler	*Leiothlypis peregrina*	2	Y	Forest and Shrub Birds
Tree Swallow	*Tachycineta bicolor*	7	Y	Aerial Insectivores
Veery	*Catharus fuscescens*	2	Y	Forest and Shrub Birds
White-crowned Sparrow	*Zonotrichia leucophrys*	2	Y	Forest and Shrub Birds
White-throated Sparrow	*Zonotrichia albicollis*	6	Y	Forest and Shrub Birds
Wilson's Snipe	*Gallinago delicata*	1	Y	Wetland and Water Birds
Wilson's Warbler	*Cardellina pusilla*	1	Y	Forest and Shrub Birds
Yellow-bellied Sapsucker	*Sphyrapicus varius*	7	Y	Forest and Shrub Birds
Yellow Warbler	*Setophaga petechia*	7	Y	Forest and Shrub Birds

Appendix 8. Priority bird species identified for Bird Conservation Regions (BCR) 7 and 8 (EC 2013, EC 2014). The Fawn River IPA and KIWDA intersect with BCR 7 and BCR 8.

BCR 8 Priority Bird Species	BCR 7 Priority Bird Species
Common Name	**Common Name**
Alder Flycatcher	Alder Flycatcher
Bald Eagle	Bald Eagle
Bank Swallow	Bay-breasted Warbler
Barn Swallow	Black-backed Woodpecker
Bay-breasted Warbler	Boreal Chickadee
Belted Kingfisher	Canada Warbler
Black-and-white Warbler	Common Nighthawk
Black-backed Woodpecker	Golden Eagle
Blackburnian Warbler	Gray Jay
Black-throated Green Warbler	Harris's Sparrow
Blue-headed Vireo	Lincoln's Sparrow
Bobolink	Nelson's Sparrow
Boreal Owl	Northern Hawk Owl
Canada Warbler	Northern Shrike
Cape May Warbler	Olive-sided Flycatcher
Chestnut-sided Warbler	Palm Warbler
Cliff Swallow	Pine Grosbeak
Common Nighthawk	Rusty Blackbird
Connecticut Warbler	Short-eared Owl
Eastern Kingbird	Smith's Longspur
Eastern Whip-poor-will	Spruce Grouse
Evening Grosbeak	Swamp Sparrow
Golden Eagle	Tennessee Warbler
Magnolia Warbler	White-winged Crossbill
Mourning Warbler	American Golden-Plover
Nashville Warbler	Black-bellied Plover
Northern Flicker	Buff-breasted Sandpiper
Northern Goshawk	Dunlin
Olive-sided Flycatcher	Eskimo Curlew
Ovenbird	Greater Yellowlegs
Peregrine Falcon (*anatum/tundrius*)	Hudsonian Godwit
Philadelphia Vireo	Least Sandpiper
Pine Grosbeak	Lesser Yellowlegs
Purple Finch	Marbled Godwit
Ruby-crowned Kinglet	Pectoral Sandpiper
Ruffed Grouse	Red Knot (rufa)

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BCR 8 Priority Bird Species	BCR 7 Priority Bird Species
Common Name	**Common Name**
Rusty Blackbird	Ruddy Turnstone
Sharp-shinned Hawk	Sanderling
Short-eared Owl	Semipalmated Plover
Swamp Sparrow	Semipalmated Sandpiper
Tennessee Warbler	Short-billed Dowitcher
Tree Swallow	Solitary Sandpiper
White-throated Sparrow	Whimbrel
Winter Wren	White-rumped Sandpiper
Yellow-bellied Flycatcher	Wilson's Snipe
Yellow-bellied Sapsucker	American Bittern
Greater Yellowlegs	Arctic Tern
Lesser Yellowlegs	Black Tern
Solitary Sandpiper	Little Gull
Wilson's Snipe	Pacific Loon
American Bittern	Parasitic Jaeger
American White Pelican	Red-throated Loon
Black Tern	Sandhill Crane
Common Loon	Yellow Rail
Common Tern	American Black Duck
Herring Gull	Black Scoter
Horned Grebe (western population)	Atlantic Brant
Red-necked Grebe	Canada Goose (Mississippi Valley)
Yellow Rail	Canada Goose (Southern James Bay)
American Black Duck	Common Goldeneye
American Wigeon	Green-winged Teal
Black Scoter	Long-tailed Duck
Bufflehead	Mallard
Common Goldeneye	Ring-necked Duck
Common Merganser	Snow Goose
Green-winged Teal	Surf Scoter
Lesser Scaup	
Long-tailed Duck	
Mallard	
Ring-necked Duck	
Surf Scoter	

5. MAMMALS AND TERRESTRIAL ECOSYSTEMS OF THE FAWN RIVER INDIGENOUS PROTECTED AREA

Prepared by Cheryl Chetkiewicz, Wildlife Conservation Society Canada

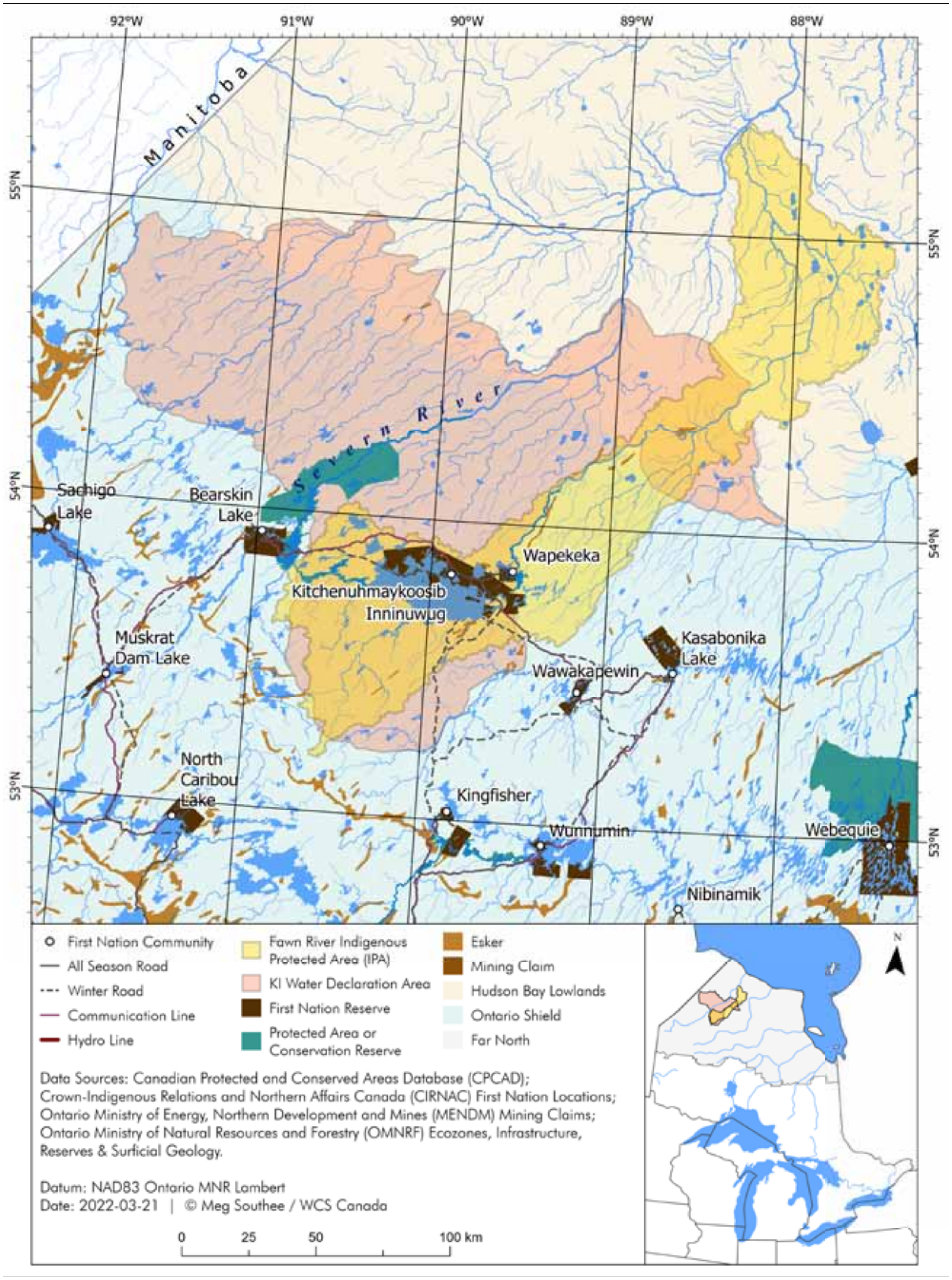
1. Terrestrial ecosystems of the Fawn River watershed

The Fawn River Indigenous Protected Area (IPA) encompasses 13,025 km of intact forests, peatlands and wetlands within the boreal biome. The boreal biome is a sub-Arctic region comprised of ecosystems within the boreal forest as well as the northernmost tundra, or taiga, ecosystems that occur above treeline. In Ontario, the taiga ecosystems are part of the Hudson Bay Lowlands (HBL) Ecozone while the boreal forest is defined by the Ontario Shield Ecozone (Figure 1)(Crins et al. 2009).

For the purpose of this chapter, two other scales are considered: Kitchenuhmaykoosib Inninuwug Water Declaration Area (KIWDA) (23,500 km^2) and the broader far north region comprised of the HBL and Ontario Shield Ecozones (452,000 km^2) (Figure 1)(FNSAP 2010).

Within these ecozones, terrestrial ecosystems and the species they support are adapted to a relatively cold and dry climate, underlying bedrock and geology affecting soil, water and plant communities and dynamics, and a relatively flat topography. The terrestrial systems in the Fawn River IPA and surrounding region are a complex and dynamic system of relationships between plants, animals and land. A number of mammal species and the terrestrial systems they depend on are culturally important to Kitchenuhmaykoosib Inninuwug (KI 2015).[1]

Figure 1. The location of Fawn River IPA and the KIWDA with relevant terrestrial features such as ecozones and eskers and current land use.



(Credit: Allan Lissner)

Boreal forests

The Fawn River IPA and the KIWDA are part of the largest single block of boreal forest free from large-scale human impact in the world (FNSAP 2010) while the portion that overlaps the HBL is part of the second largest peatland complex in the world (see Peatlands section). The diversity of terrestrial ecosystems enables predator-prey dynamics, competition and other ecological interactions between mammals, multi-species communities, and the biophysical environment. The broader region is also exceptional in Ontario because it supports populations of large mammals, including caribou, moose and wolves some of which are in decline throughout Ontario and Canada.

Boreal forests – their composition, age and distribution – in the Fawn River IPA and KIWDA are a result of fire that has created dynamic mosaics of habitat. Approximately 3.7 % of the Fawn River IPA has burned during 1960 to 2020 compared to burns across 4% of the KIWDA during this period (Figure 2). Historically, the boreal fire season has a peak in late April-May and another peak in August and early September. Since the 1980s, however, spring fires have become more intense due to decreased moisture as winter snowfall (Abraham et al. 2011). The structure and composition of the forest is also influenced by beaver activity, wind and insect infestations (Crins et al. 2009).

The composition of boreal forest in the Fawn River IPA includes categories of deciduous, conifer and mixed-forest types based on the Far North Land Cover v.1.2. layer. The Fawn River IPA contains 16% water, 59% peatlands, 11% conifer, 6% mixed and deciduous, and 6% classified as disturbance (Figure 3). This composition is similar to the KIWDA, except the KIWDA has 12% classified as disturbance (Figure 3). Overall, forest composition is similar to boreal forests across northern Canada where black spruce is a dominant species and white spruce, jack pine, aspen, tamarack and white birch may also be present (Abraham et al. 2011).

Tree growth, forest productivity, and terrestrial ecological dynamics in the area remain poorly studied and monitored by science. The ecological limits of tree growth in this sub-Arctic region have implications for sustainability of forest ecosystems when economies are based on industrial extraction, including recent proposals focused on forestry and biomass power generation for rural and remote communities (Government of Canada). Approaches to commercial forestry management and planning should be considered more carefully in the northern remote regions where productivity and growing seasons are short and there are multiple social and ecological values besides timber and employment.

Figure 2. The burn history affecting boreal forests in and around the Fawn River IPA.

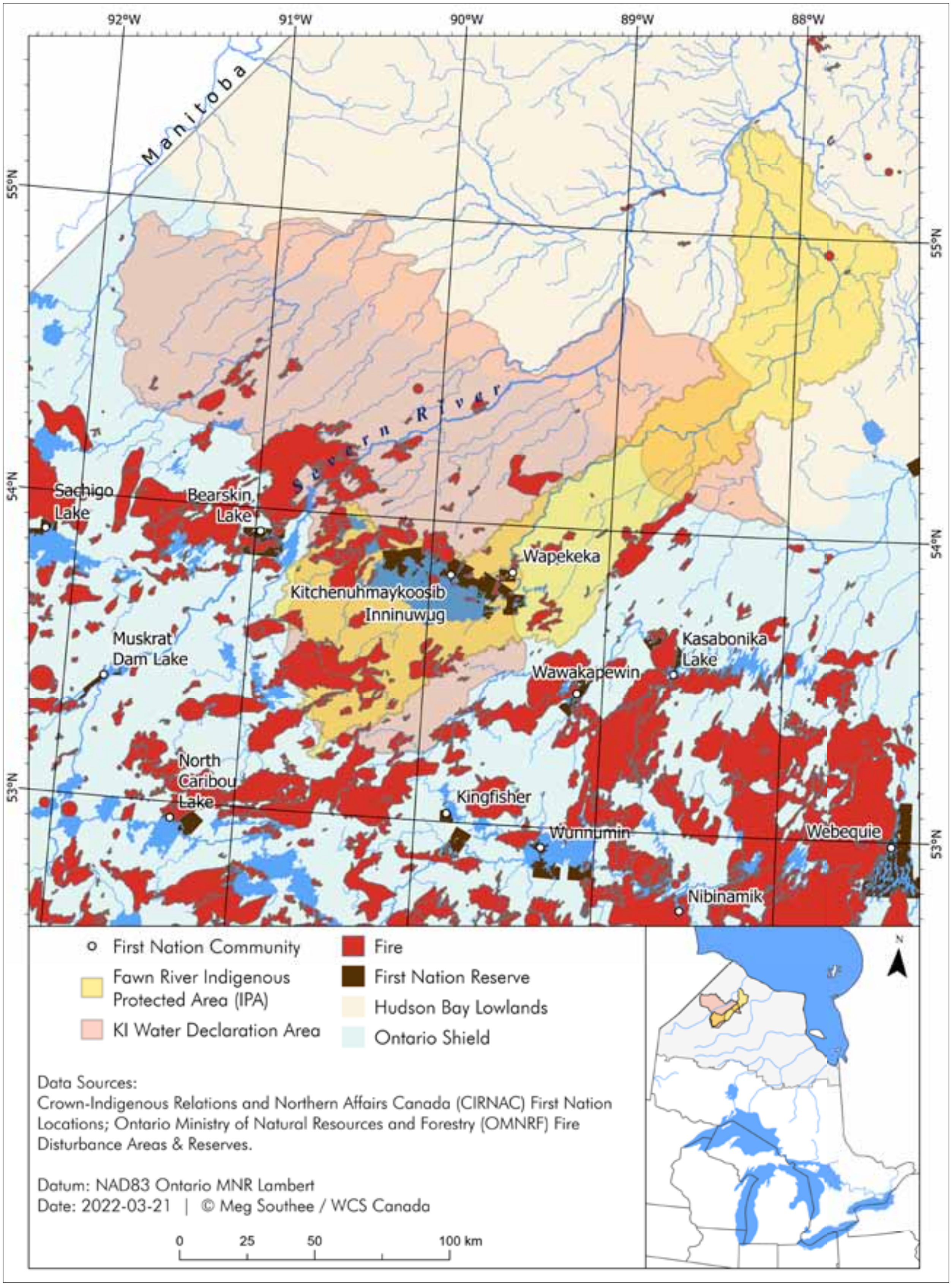
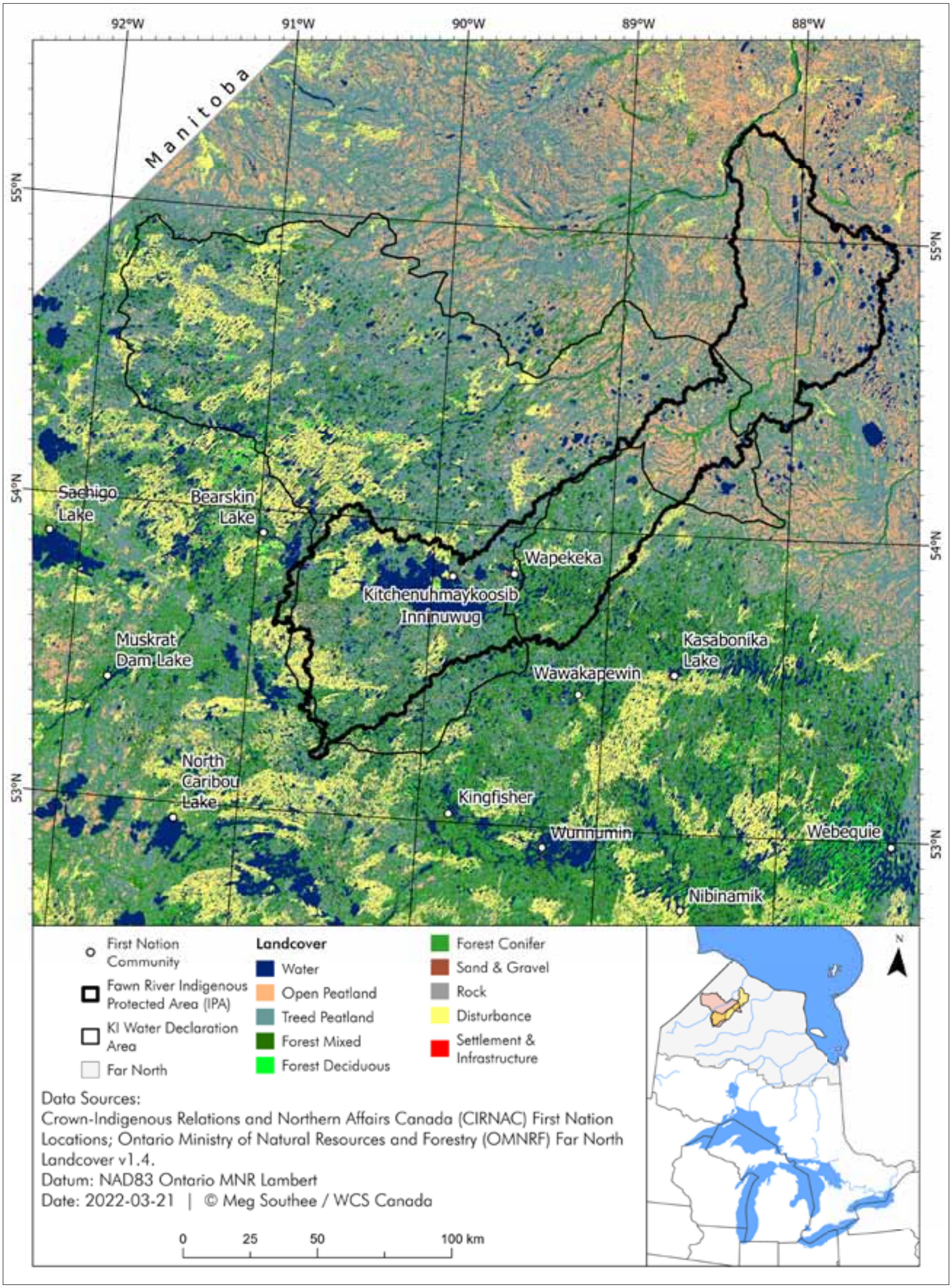


Figure 3. The land cover types associated with the Fawn River IPA and KIWDA highlighting the forest types associated with the Ontario Shield and the peatland and wetland types associated with the Hudson Bay Lowlands.



The Fawn River IPA also extends into the HBL (see Peatlands section). Wetlands and peatlands provide habitats for fish, wildlife and plants, and their functions are influenced by the presence of continuous and discontinuous permafrost. Boreal forests are also critical for freshwater processes where mammals like American beaver affect lowland freshwater habitats including streams and ponds through their activities.

Eskers

Eskers are remnants of past glacial activity on the landscape and consist of loose unfrozen gravels, providing local relief in a relatively flat region (Crins et al. 2009). Eskers occur throughout the Fawn River IPA and the KIWDA.

Eskers in similar environments have been shown to be important travel routes for caribou and other mammals (McLoughlin et al. 2004). Eskers also are likely important for mammals like wolves and wolverines that build maternal dens in which to give birth and to protect their young from exposure to predators and the weather (Johnson et al. 2005).

Eskers are typically identified as aggregate for human activities such as road building and aggregate pits. However, their importance as upland features suggest that eskers and their conservation should be part of a broader strategy of environmental planning.

2. Mammal biodiversity of the Fawn River IPA

Biodiversity is a scientific term that literally means the diversity of living things and their relationships to each other. In general, the more species and interconnected relationships there are, the more resilient the whole system is to impacts from industrial development and climate change (Cleland 2011). While biodiversity is often described as animals and their habitats, it is important for humans. Biodiversity supplies people with food, clean water, soils for food, energy and materials, and is the basis for different types of economies that humans consider important for their well-being and quality of life. Decreasing biodiversity diminishes the ability of ecosystems to maintain and provide these "services" to people and their communities. In the far north region, these services are also tied to the rights of First Nations under Treaty No. 9.

The diversity of terrestrial mammal species in the Fawn River IPA and northern Ontario more generally is driven, in part, by temperature (Kerr & Packer 1998). Mammals associated with the Arctic (e.g., Arctic fox) tend to be found in the more northerly portions of the region, while a greater diversity of mammals that depend on the boreal forest are distributed further south and inland. Northern limits of mammals are typically linked to climate (e.g., temperatures, precipitation) whereas southern limits tend to be determined by interactions with other species through competition and predation as well as impacts from humans and their land uses. Climate change will have important implications for northern mammals in terms of changing distribution and abundance (see Threats below)(Varrin et al. 2007).

There are 53 species of mammals in the far north region including beaver, muskrat, grey wolf, red fox, black bear, polar bear, wolverine, marten, mink, otter, lynx, moose and caribou (FNSAP 2010). Arctic fox and northern bog

There are 53 species of mammals in the far north region including beaver, muskrat, grey wolf, red fox, black bear, polar bear, wolverine, marten, mink, otter, lynx, moose and caribou.

Given the cumulative effects of land use and climate change, further research and monitoring led by the community should be explicitly included in planning and decision making about the biodiversity and ecosystems that comprise the Fawn River IPA.

lemming may also be present in the HBL portion of the Fawn River IPA. Some of these species such as caribou, moose and furbearers are important to First Nations in part because of their role in subsistence and traditional economies as well as their importance as cultural and spiritual values (Ray 1998, Fritz et al. 2003, Johnson & Myanishi 2012).

Scientific knowledge about the abundance, distribution and status of most mammal species and their populations is poor across northern Ontario. Few mammals have received research focus and population monitoring by scientists, primarily within government agencies. In general, this is due to the remoteness of the area, the expense of conducting scientific research and monitoring, and government priorities. However, the remoteness and low levels of industrial development mean this region is important for mammals whose populations have declined due to human land use and activities elsewhere in Ontario including caribou, wolverine, Canada lynx, grey wolf, American marten and polar bear.

Another important consideration in understanding the abundance, distribution and status of mammal populations in the region is that boreal ecosystems are dynamic and affected by fire, floods and insect outbreaks as well as shifting weather patterns that affect temperature and precipitation. More research is needed to consider how Indigenous Knowledge Systems and science can provide the best available knowledge to consider the past, current and future conditions of mammals and the ecosystems they are interconnected with.

Future conditions in the north that will affect the Fawn River IPA and KIWDA likely include more industrial land use such as roads, mining, hydroelectric development and forestry together with a changing climate. Climate is affecting ecosystems and species even in the absence of land use activities (Newbold 2018). Given the cumulative effects of land use and climate change, further research and monitoring led by the community should be explicitly included in planning and decision making about the biodiversity and ecosystems that comprise the Fawn River IPA (see Threats below).

(Credit: Allan Lissner)

First Nations have inherent rights as well as constitutionally protected Aboriginal and Treaty Rights to trap and hunt mammals across Treaty No. 9. Trapping and hunting of wildlife remains an important component of food sovereignty and the basis of traditional Indigenous economies in northern Ontario.

The scientific state of knowledge about some terrestrial mammals including polar bear, caribou, moose, wolverine, grey wolf, American marten, American beaver and bats are described in more detail below.

Polar bears, *Ursus maritimus*

Polar bears are top predators structuring predator-prey dynamics and ecological flows within Arctic marine ecosystems (Peacock et al. 2011). Scientists describe two subpopulations of polar bears: Western Hudson Bay and Southern Hudson Bay (Tonge & Pulfer 2011). Individuals move between Ontario and adjacent islands in Nunavut and the Québec-Nunavik coast and are at their southern limit in the far north in Ontario. Bears of the South Hudson Bay subpopulation summer on land in Ontario and on islands in James Bay. Harvest of polar bears is managed by governments of Manitoba, Ontario, Québec and/or Nunavut Wildlife Management Boards, as well as First Nations communities.

Scientists' understanding of polar bear ecology, distribution and population status is based on data collected using satellite telemetry and aerial surveys, conducted primarily by the Ontario Ministry of Natural Resources and Forestry (OMNRF). In 2016, scientists estimated there were 718 individuals in the Southern Hudson Bay subpopulation, down from 943 in 2011 (Obbard et al. 2018).


(Credit: Brandon LaForest)

Polar bears rely on the ice of Hudson Bay and James Bay where their distribution depends on their primary prey species – ringed seals. During the ice-free season, polar bears require extensive undisturbed coastal habitats where pregnant females spend up to eight months on shore without feeding. Female polar bears may den as far inland as 150 km and select similar areas for denning each year. Polar Bear Provincial Park in northern Ontario was designated, in part, to protect onshore polar bear habitat.

Even though population numbers have been stable over the past 25 years, scientists have measured dramatic declines in body condition for pregnant females and sub-adult bears in the South Hudson Bay subpopulation since 1984 (Obbard et al. 2018). Some scientists have suggested that the subpopulation may be at an "ecological tipping point or threshold" (Peacock et al. 2011).

Importance of polar bears

Polar bears are designated as Threatened in Ontario under the *Endangered Species Act* (ESA) and Special Concern under the federal *Species at Risk Act* (SARA). OMNRF has developed a strategy for polar bears in Ontario describing goals and objectives for polar bear recovery (Tonge & Pulfer 2011).

Polar bears are of international interest because of their circumpolar distribution, the impacts of climate change on their sea-ice habitats, and the measurable declines in body condition and survival rates. Monitoring of polar bears as sea-ice habitat declines is considered critical.

Economic revenues from ecotourism (e.g., polar bear viewing) and guiding of sport hunters based on harvest quotas allocated to Indigenous communities is considered an important ecosystem service by governments in some parts of sub-Arctic and Arctic Canada and a source of revenue for Inuit and some First Nations communities.

Cervids

Cervids is the scientific term for members of the deer family, which includes caribou, moose, white-tailed deer and elk. All deer species have important ecological roles, but their value to Ontario has largely focused on recreational harvest and reducing human-wildlife conflicts.

Ontario's overarching policy advice on the management of different deer species is described in the Cervid Ecological Framework (Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry 2018). The Fawn River IPA overlaps with Wildlife Management Units (WMU) 1A (7.6%), 1C (5.9%) and 1D (0.1%) as well as Cervid Ecological Zone A (2.4%) (Figure 4).

In this zone, OMNRF prioritize caribou management by reducing habitat impacts and maintaining sustainable populations of caribou, as directed by the caribou conservation plan, while maintaining low densities of moose and white-tailed deer through population and habitat management.

(Credit: Justina Ray/WCS Canada)

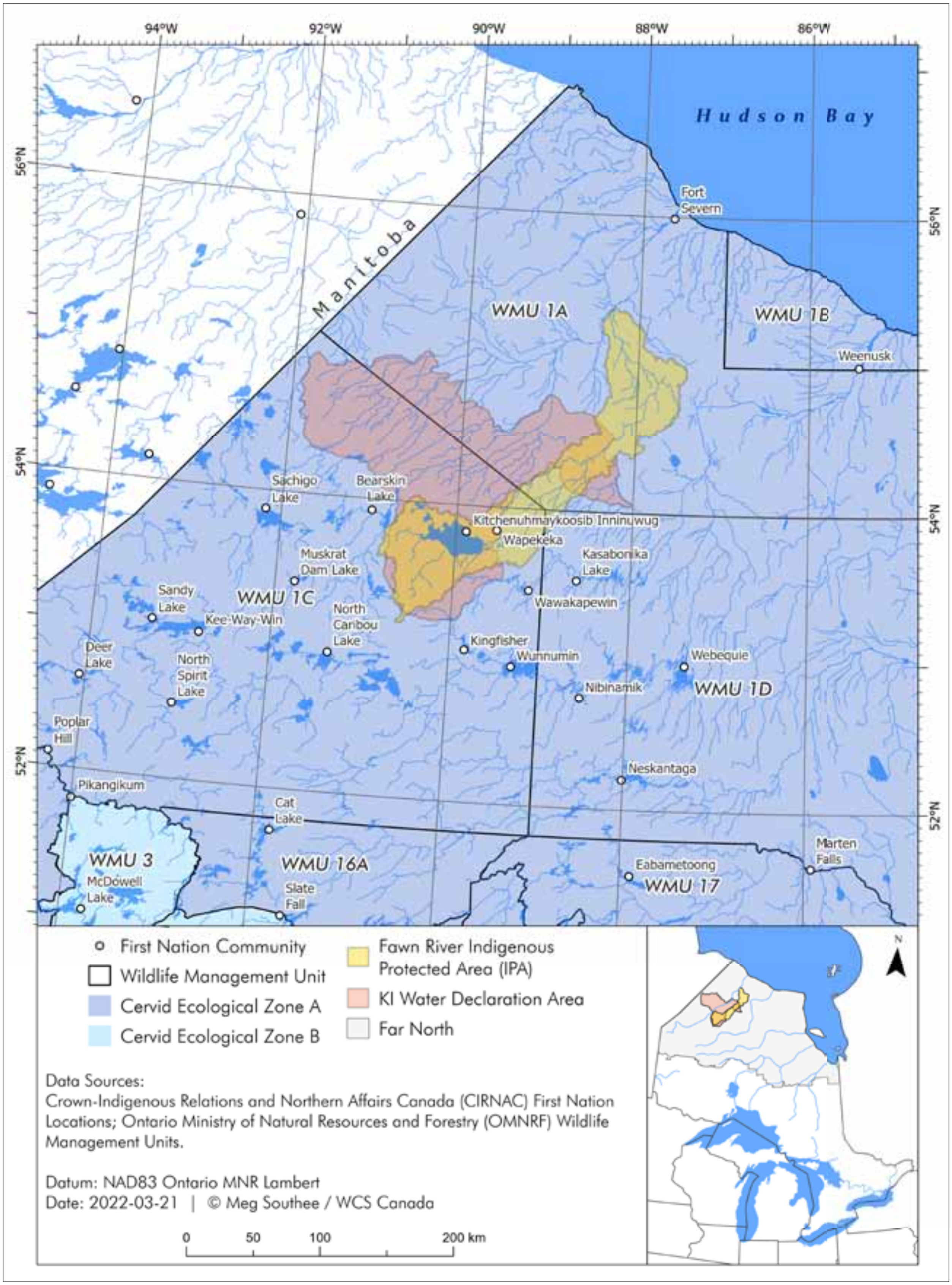
Caribou, *Rangifer tarandus*

Caribou were once distributed across Ontario but their range has retracted northward by almost 50% since the 1900s (Schaefer 2003). In Ontario, scientists describe two different types (or ecotypes) of caribou based on their movement behaviours and habitat preferences: a sedentary boreal-forest type and a migratory forest-tundra type. The two caribou ecotypes are also considered to belong to separate designatable units (DUs) by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2011). Both types of caribou overlap in Ontario and can move among habitat types and change their movement behaviours, particularly in the winter (Pond et al. 2016). The migratory caribou calf along the coast, while caribou in the boreal forest spread out from one another. Scientists think this behaviour helps to reduce the risk of predation by wolves (OMNRF 2014).

Caribou use the entire landscape, moving as the forest changes. Caribou habitat includes large patches of mature forest, dominated by coniferous tree species such as black spruce and jack pine. Disturbances due to human activities and natural disturbances like fire change the amount and distribution of caribou habitat. Despite these dynamics, caribou use of certain areas can be remarkably consistent, particularly for calving and wintering areas (e.g., Schaefer et al. 2000) and scientists try to identify these areas to ensure they are considered in land-use planning and impact assessment (e.g., Berglund et al. 2014).

Scientists consider caribou to be indicators of "ecological integrity" and healthy boreal forest ecosystems because they require large areas of undisturbed mature coniferous forest and are sensitive to human disturbance causing habitat loss and fragmentation (Bowman et al. 2010) as well as natural disturbance such as forest fires and blowdown (Racey & Armstrong 2001). Habitat for caribou in northern Ontario, including the Fawn River IPA and KIWDA, is considered to be abundant.

Figure 4. The various boundaries, such as Wildlife Management Units and Cervid Ecological Zones, used by Ontario to monitor and manage wildlife in areas that intersect with the Fawn River IPA and KIWDA.



Scientists' understanding of caribou ecology in the boreal forest is based on 15 years of Global Positioning System (GPS)-satellite telemetry and radio telemetry (e.g., collared animals) as well as winter aerial surveys to obtain population information on caribou across their range. In 2014, OMNRF estimated there were a minimum of 3,334 caribou among the designated ranges and populations are in decline (Figure 5). The migratory herd of caribou in northern Ontario has been monitored by the OMNRF starting in 1979 through summer coastal aerial surveys (Magoun et al. 2005, Abraham et al. 2012).

There is no legal non-Indigenous hunting of caribou allowed and hunting by First Nations is considered to be around 10%, but remains largely unknown for the purpose of management and understanding population dynamics.

Wolves are considered to be the most important natural driver of caribou behaviour and population dynamics (Serrouya et al. 2019). Higher wolf numbers, supported by stable and increasing moose densities, can lead to increased predation of caribou (Fryxell et al. 2020). Unlike fire, human disturbance such as commercial forestry, mineral exploration and oil-and-gas development alters predator-prey dynamics by enhancing moose habitat (Latham et al. 2011, Serrouya et al. 2020) and increasing wolf predation efficiencies through linear features such as roads (Kittle et al. 2017, Dabros et al. 2018, DeMars et al. 2019). Human activities, fire and wolf population dynamics are all predictors of caribou population dynamics and distribution (DeMars et al. 2019).

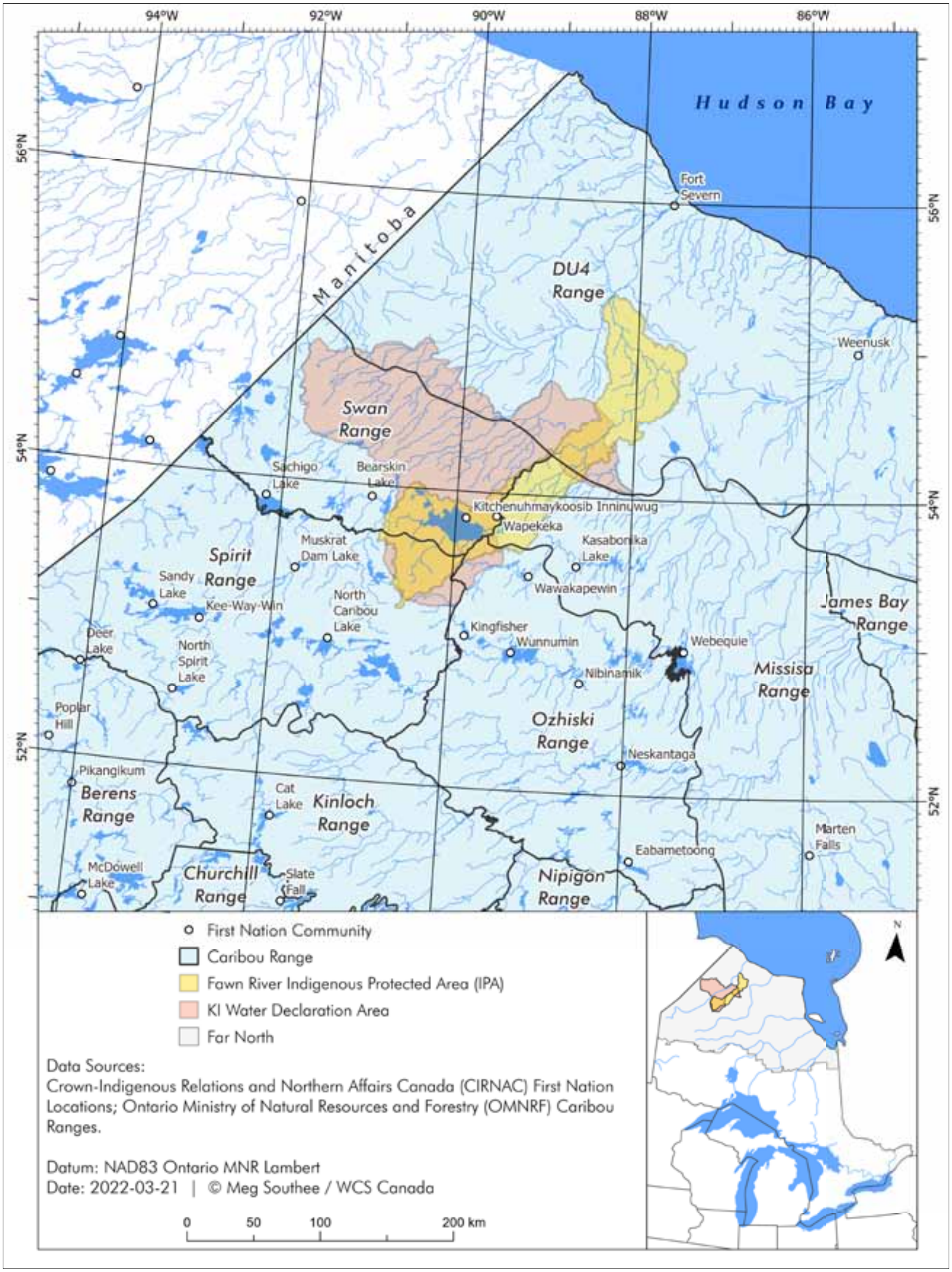
(Credit: Justina Ray/WCS Canada)

What we know about caribou in the Fawn River IPA and KIWDA

The Fawn River IPA and the KIWDA intersect with the following caribou ranges: Spirit (11.9%), Ozhiski (0.7%), Missisa (3.5%), and Swan (11.9%) (Figure 5). Fifty-eight percent of the Swan range is protected by the KIWDA. In 2014, OMNRF determined that the Swan and Ozhiski range conditions were sufficient to sustain caribou populations, but recruitment rates were low. There was not enough data in 2014 to determine the sustainability of caribou on Missisa and Spirit ranges.

- Rempel and his colleagues (2021) used scenarios of land use and climate change to assess their cumulative effects on caribou ranges in the far north including Missisa and Spirit ranges. Their simulations suggested that Ontario's boreal woodland caribou population is likely to continue to decline in the absence of management strategies that address the cumulative effects (at multiple scales) of climate change and development to the region's moose-wolf-caribou system.
- Fryxell and his colleagues (2020) determined caribou populations on ranges without commercial forestry showed less evidence of population decline compared to those ranges with forestry. They also found that there is only a 17.9% probability that the population on Spirit range is increasing with similar values for Ozhiski (17.9%), Missisia (21.6%), and Swan (17.7%).

Figure 5. Caribou ranges defined by Ontario's Ministry of Natural Resources and Forestry to monitor and manage migratory and sedentary ecotypes of caribou that live and move through the Fawn River IPA and KIWDA.



- Hornseth and Rempel (2016) used telemetry data to develop mathematical models of resource selection by caribou. The regional model predicted higher caribou resource selection in areas with less apparent competition with moose; were less disturbed by fire and human activities such as roads and commercial forestry; and where preferred caribou foods, including lichen and browse, were highest. Their results for Spirit and Missisa suggest higher probabilities of resource use in the northern sections of the ranges that overlap with the Fawn River IPA and KIWDA.
- Poley and her colleagues (2014) developed mathematical models of caribou occupancy in the region using winter aerial surveys conducted by OMNRF during 2009-2011 (Figure 6). Caribou occurrence in the Spirit, Swan and Ozhiski ranges was higher on peatland complexes and lower in younger aged forest types. They also found that caribou occurrence was comparatively higher near provincially protected parks like Wabakimi and Woodland Caribou due to lower levels of human disturbance.

Land use activities within the IPA must be monitored to ensure impacts to caribou do not increase at the range scale.

These studies highlight that the primary threat to caribou on ranges that intersect with the Fawn River IPA are associated with human activities that lead to increased predation risk either through the development of roads and linear features and by changing the composition of the forest to young age classes and species that support moose and alternative prey. Fawn River IPA is an important area for caribou that may be impacted by human activities as forestry, roads and mineral activity move further north, changing forest habitats and predator-prey dynamics. Land use activities within the IPA must be monitored to ensure impacts to caribou do not increase at the range scale.

Migratory populations of caribou

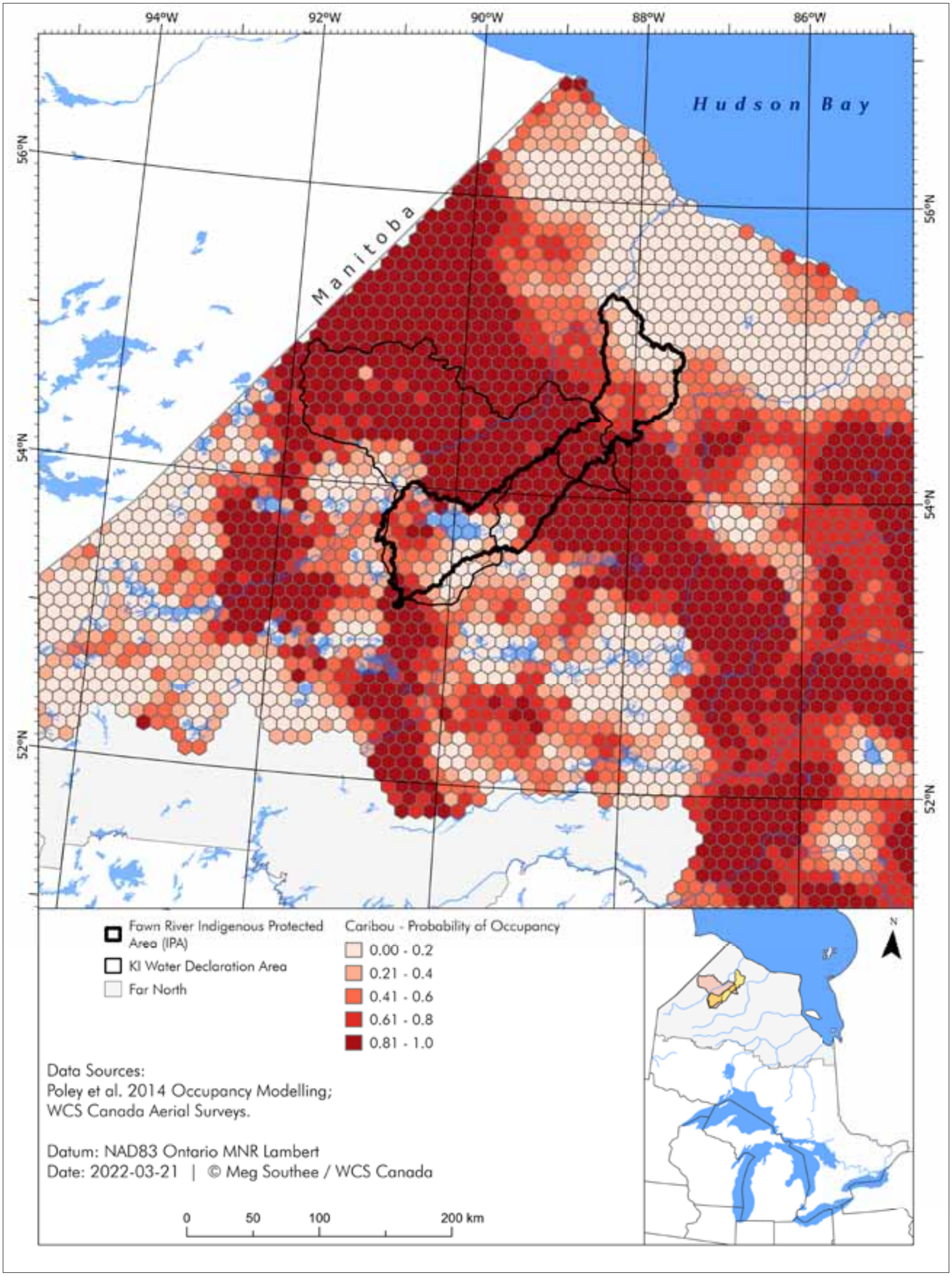
The Fawn River IPA and KIWDA overlap with the range of eastern migratory caribou (DU 4 Range in Figure 5). Aerial surveys revealed that the distribution of caribou during summer changed markedly over the years based on aerial surveys. There were a total of 16,638 caribou reported in 2011 (Newton et al. 2015). Newton and her colleagues (2015) indicated that migratory caribou altered their distribution both eastward, to avoid all-terrain vehicle (ATV) disturbance and seek better forage, as well as inland away from ATV activity on the coast. The use of ATVs for hunting also obscures the effects of hunting and ATV disturbance on migratory caribou in the summer (COSEWIC 2017), while winter roads appear to facilitate winter harvest of caribou (COSSARO 2017).

Importance of caribou

Both migratory and sedentary ecotypes of caribou are of national and international interest due to the impacts of human activities such as forestry and oil and gas in the boreal forest and on the Arctic tundra, respectively.

- Caribou have lost over 50% of their range and distribution in Ontario since the late 1800s (Schaefer 2003). In 2009, Ontario developed the Caribou Conservation Plan (CCP) in response to conservation concerns about the status of caribou in the province (OMNR 2009). The CCP is the basis for provincial policy on the conservation and recovery of caribou and their

Figure 6. Average probability of occupancy for caribou, where 0 (light pink) is low and 1.0 (dark red) is high, based on aerial survey data (Poley et al. 2014).



habitats in Ontario. The boreal caribou was assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO) under the Ontario *Endangered Species Act* (ESA). Ontario considers the boreal population to be Threatened (COSSARO 2015) and the eastern migratory population as Special Concern (COSSARO 2017).

- Boreal woodland caribou across Canada are in decline and their ranges have receded in the face of human activities (Festa-Bianchet et al. 2011). In 2011, COSEWIC identified 12 DUs of caribou across Canada. Caribou using the Fawn River IPA and KIWDA fall within the eastern migratory DU 4 (Endangered, COSEWIC 2017) and the boreal DU 6 (Threatened, COSEWIC 2014a).
- The boreal caribou DU is listed as Threatened on Schedule 1 of SARA since 2002 and subject to a federal Recovery Strategy since 2012 (Environment Canada 2012). Due to the scientific evidence for the relationships between caribou and habitat disturbance, the federal recovery strategy for boreal caribou (Environment Canada 2012) recommends limiting the total amount of natural and human disturbance on a range (i.e., habitat that is < 40 years old) to no more than 35% total.


(Credit: Garth Lenz)

Moose, *Alces alces*

Moose is a species of ecological and social significance as an important food source for First Nations as well as predators such as wolves and black bears. Moose are the largest member of *Cervidae* family and spend much of their time foraging across aquatic and deciduous habitat types. This preference is moderated by human activities, including hunting, and the presence and density of grey wolves (Street et al. 2015a). Disturbances such as industrial forestry tend to increase the abundance of deciduous habitat by resetting the forest to earlier successional stages. However, roads created to remove timber can also increase predation risk for moose from wolves and human hunters, increasing moose mortality (Rempel et al. 1997, Street et al. 2015b). In the boreal, fire also alters succession patterns and forest regeneration resulting in deciduous plants preferred by moose.

What we know about moose in the Fawn River IPA and KIWDA

The Fawn River IPA and KIWDA likely provide preferred habitats for moose including better drained riparian areas and areas where burns have occurred in the last 20-30 years. These areas provide food for moose as well as cover to avoid predation.

Rempel and his colleagues (2021) indicated that for much of the far north region, moose may have only recently occupied the area in response to climate change or may be increasing in number in areas where they were already present. However, there are no empirical estimates of density.

Poley and her colleagues (2014) developed statistical models based on aerial surveys of large mammals during 2009-2011 and found moose occupancy on the Ontario Shield was lower where bogs were extensive and higher where forest habitat disturbance was greater (Figure 7). In the HBL, they found occupancy was greater where terrain was more rugged.

Beyond these surveys, research on moose has been largely focused on the near north and central areas of Ontario that are south of the Fawn River IPA and KIWDA.

- Found and his colleagues (2017) documented wolf diets in the Ogoki-Nakina forest where moose density (11.8/100 km^2) and wolf density (0.67/100 km^2) were considered to be moderate. They found wolf scats contained mostly moose (87%) followed by American beaver (10.9%). Only 3.1% of wolf scats contained caribou suggesting moose were a major dietary component of wolves.
- Street and his colleagues (2015b) developed a statistical model using moose estimates based on surveys of WMUs in Ontario to predict moose carrying capacity. They found that carrying capacity generally increases from east to west and from south to north based on the forest productivity gradient across Ontario. They suggested this gradient affects forage abundance and habitat availability and consequently moose populations and distribution also follows this gradient. Their analyses did not extend to areas that overlap with the Fawn River IPA and KIWDA.
- Rempel (2011) examined the response of moose to climate change based on a statistical model of moose carrying capacity and climate-change scenarios and predicted a retraction of moose at their south limits of their distribution and an expansion at the northern edge. Rempel's predictions do not extend beyond the Area of Undertaking (AOU).

More co-created research with First Nations is needed given the lack of scientific information on moose population dynamics, distribution and relationships to First Nations. These are important gaps in our understanding of moose in the Fawn River IPA and KIWDA.

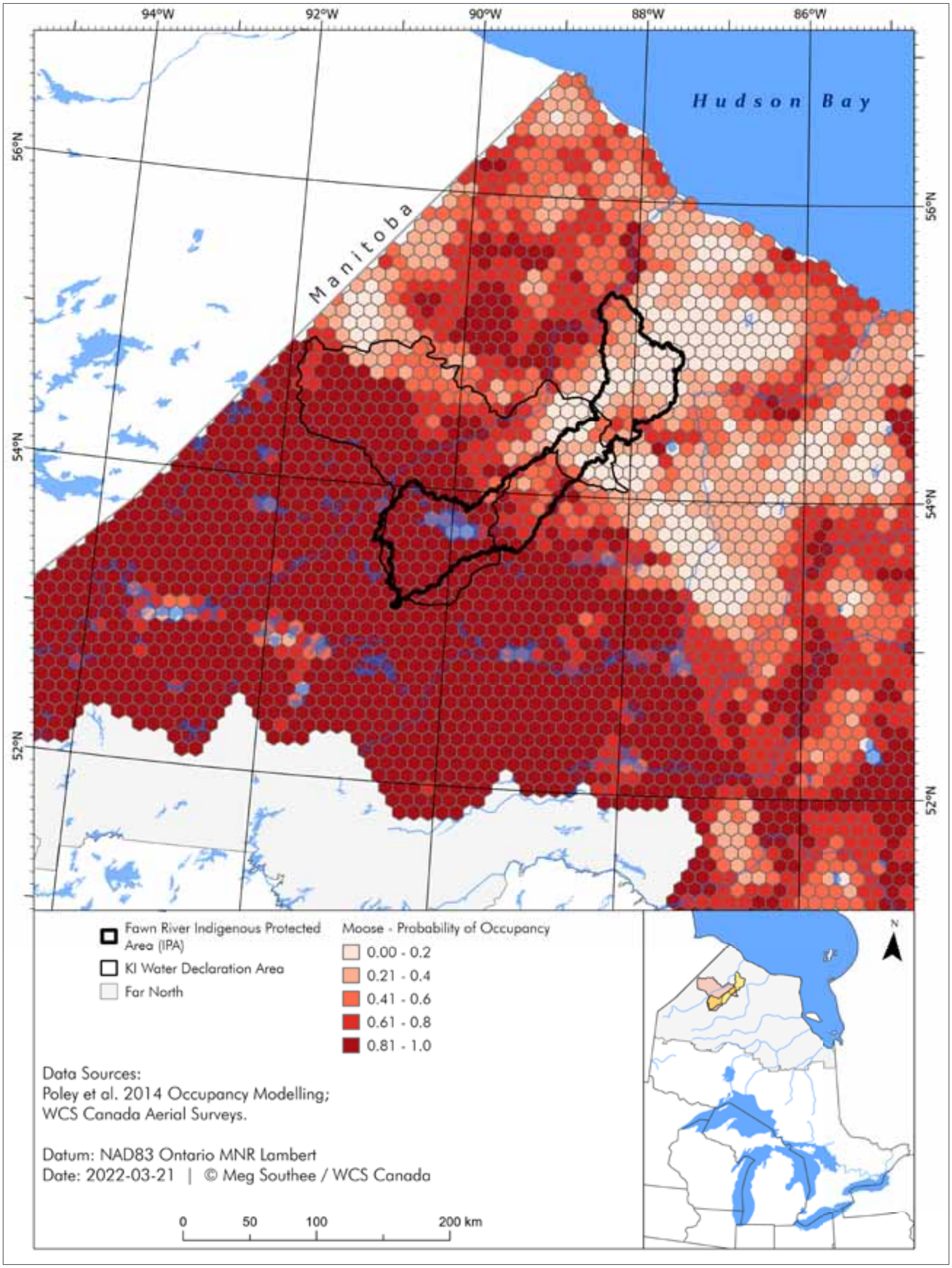
Importance of moose

Moose have been managed primarily for recreational hunters throughout Ontario based on WMUs. WMU 1A, 1C, and 1D overlap with the Fawn River IPA and KIWDA (Figure 4) however Ontario has not regularly scheduled moose population monitoring in these WMUs.

The most recent estimates (2022) suggest 9,980 moose occur across these WMUs (Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry 2022). Moose densities vary across the region, but tend to be lower in areas of the Hudson Bay Lowlandss compared to the Ontario Shield with an estimated 0.2 moose/100 km^2 based on surveys conducted by OMNRF from 1982-1986.

Moose are a cultural keystone species for many First Nations (Parlee et al. 2012, Popp et al. 2020). More co-created research with First Nations is needed given the lack of scientific information on moose population dynamics, distribution and relationships to First Nations. These are important gaps in our understanding of moose in the Fawn River IPA and KIWDA.

Figure 7. Average probability of occupancy for moose, where 0 (light pink) is low and 1.0 (dark red) is high, based on aerial survey data (Poley et al. 2014).



Furbearers

Furbearer species have significant cultural and economic importance across North America (Webb & Boyce 2009) and were severely impacted by the fur trade in northern Ontario (Lytwyn 2002).

Lytwyn described declines in beaver returns that were exacerbated by mild winters, flooding and drought-fueled fires while marten populations declined as a result of high pelt prices and overharvest. The migration of labourers onto traplines during hydroelectric and railway developments in northern Ontario during the 1950s also had negative population impacts on furbearers across the region (Abraham et al. 2011).

It is unknown to what extent furbearers across the region, including within the Fawn River IPA and the KIWDA, have recovered from this exploitation (Abraham et al. 2011). In general, while harvesting is considered to be less intensive today than in the past, trapping and hunting of furbearers is often tied to pelt prices, which are highly variable and species specific. Trapper and hunter effort over time and space is difficult to quantify.

Wolverine, *Gulo gulo*


(Credit: Liam Cowan / WCS Canada)

Wolverine are the largest terrestrial member of the *Mustelidae* family that includes weasels, badgers, otters, ferrets, mink and marten, among others. Wolverines are well adapted to boreal and tundra environments found within the Fawn River IPA, KIWDA and the broader region.

For example, wolverine fur is dense, short and thick while their feet are proportionately large and well adapted for travel on top of the snow. While wolverines will eat just about anything (i.e., generalist), they have large skulls and strong jaws that enable them to crush the bones of larger prey animals, including moose and caribou, which they typically scavenge from wolf kills (van Dijk et al. 2008).

Wolverines are found in habitats across northern Ontario where they can access their preferred food including moose, caribou and beaver (Scrafford & Boyce 2018). While wolverines depend on wolves for carrion, wolves also kill wolverines (Scrafford et al. 2017). Female wolverines also require specific habitat types for maternal dens.

Wolverine tend to have large home ranges. For example, Dawson and colleagues (2010) documented male and female home ranges as 2,563 km^2 and 428 km^2, respectively. The combination of naturally low population densities, large home-range sizes, long-distance movements, and low reproductive rate make wolverine vulnerable to overharvest, particularly trapping, which is currently illegal due to their conservation status in Ontario. Overharvest is most often associated with roads that allow human access into wolverine habitats.

Similar to caribou, wolverine were once distributed throughout Ontario, but their range has receded since the mid- to late-1800s due to direct mortality such as hunting and trapping, and loss of habitat due to human settlement, commercial forestry, railway construction and decreasing populations of prey species, particularly moose, caribou and beaver (COSEWIC 2014b). The decline in wolverine numbers in northern Ontario was generally coincident with a decline in woodland caribou in that part of the province and today they are largely confined to northwestern Ontario (Ontario Wolverine Recovery Team 2013). Generally, wolverine tolerance for human activities such as roads, mineral exploration and mining, and settlements depends on the scale and context. For example, there is good evidence that wolverines exist in areas with industrial development and roads (home ranges encompass developed areas). Whereas at finer scales, wolverines often avoid these developments leading to habitat loss. Development in boreal forest ecosystems can increase mortality in wolverine populations (e.g., Scrafford et al. 2018).

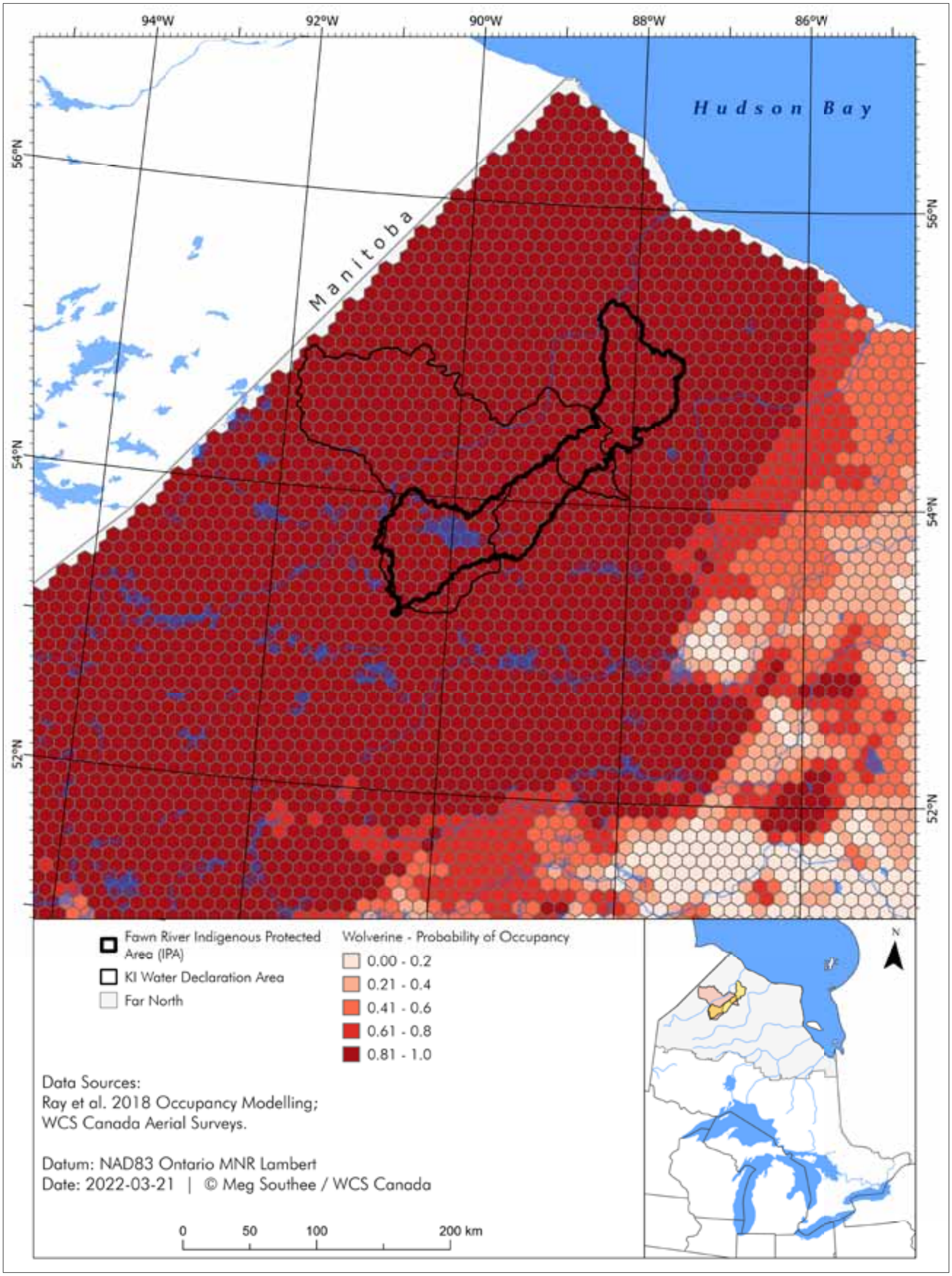
What we know about wolverine in the Fawn River IPA and KIWDA

Wolverine research and monitoring has been conducted in northern Ontario since 2001 and includes aerial survey, camera-trap monitoring and trapper surveys to gain a better understanding of wolverine ecology, distribution and test-monitoring approaches.

- Ray and her colleagues (2018) used mathematical models based on seven winter aerial surveys over a 10-year period (2003-2012) to predict the probability of wolverine occupancy across northern Ontario, including areas that overlap with the Fawn River IPA and the KIWDA (Figure 8).
- WCS Canada also led a wolverine radio telemetry study in Red Lake, Ontario from 2003-2005 (Dawson et al. 2010) and was a major partner in a similar wolverine radio telemetry study in the northern boreal forest in Alberta from 2013-2016 (Scrafford et al. 2017). WCS Canada is currently repeating the telemetry work out of Red Lake (Ray 2018) using GPS-satellite telemetry to better understand wolverine recovery since 2005 and wolverine responses to human activities, including forest-management planning (Scrafford et al. 2021). Scrafford and his colleagues are also conducting research in support of guidelines for maternal den-site protection and understanding the cumulative impacts of incidental trapping and forestry south of the Fawn River IPA. WCS Canada is working with Indigenous and non-Indigenous trappers on this project and supporting community-based monitoring of wolverines with Aroland First Nation.

These studies highlighted the need to limit industrial activity and infrastructure, particularly roads that make wolverine vulnerable to human-caused mortality such as trapping as well as more vulnerable to wolf predation. This work may offer a better understanding of wolverine population dynamics across gradients of natural and human disturbance that could support the importance of the Fawn River IPA as a roadless area or refugia to reduce human-caused mortality for wolverines (e.g., Kortello et al. 2019).

Figure 8. Average probability of occupancy for wolverine, where 0 (light pink) is low and 1.0 (dark red) is high, based on aerial survey data (Ray et al. 2018).



Importance of wolverine

Wolverine are a species of conservation concern. Together with Manitoba, northern Ontario represents the eastern extent of the national western population, designated by the COSEWIC as Special Concern (COSEWIC 2014b). Wolverine were listed as Special Concern under SARA in 2018.

In Ontario, wolverine have been classified as Threatened under the Ontario ESA. This is because of low number of wolverines (< 1,000) in the province (Justina Ray, personal communication). Wolverine have also experienced a decrease in their range and tend to have low reproductive rates and large home-range sizes, which means their populations are slow to recover from the loss of many individuals.

Ontario has developed a wolverine recovery strategy to support conservation goals and objectives across their range in Ontario (Ontario Wolverine Recovery Team 2013) in addition to a Government Response Statement detailing Ontario's commitments to recovering wolverine (Ontario Ministry of the Environment, Conservation and Parks 2016).


(Credit: Jerry Lee)

Grey wolf, *Canis lupus*

Grey wolves are social predators at the top of boreal-terrestrial food webs and they are the largest undomesticated members of the dog family, *Canidae*. As such, wolves are integral to healthy and functioning ecosystems and a key component of northern biodiversity.

Wolves are a highly adaptable and effective predator of large mammals having both direct and indirect impacts on their prey populations. Besides moose and caribou, beaver may be seasonally important for grey wolves during the snow-free period and when beaver may be more active on land in late April through May (e.g., Found et al. 2017). They also influence other ecosystem components and processes that scientists are only just beginning to consider (e.g., cascading functions, Fortin et al. 2005).

Ray and colleagues (cited in Abraham et al. 2011) described wolves as "widespread but scattered" throughout the northern portion of the Hudson Bay Lowlands that overlaps with the Fawn River IPA and the KIWDA. Wolves are generalists and their distribution and relative abundance across different habitats tend to be more closely tied to those of their preferred prey (Found et al. 2017). Pack sizes tend to be smaller in the north, with larger territories and lower densities, however scientific research and monitoring of grey wolves in northern Ontario is limited.

Wolves require adequate prey abundance and habitats across multiple scales and may exhibit different tolerances for human activities (e.g., Gurarie et al. 2011) although the relationship with linear features such as roads is complicated. Road densities are often used as proxies for human impacts on wolves with increased wolf mortality and lower population persistence occurring when road densities are greater than 0.45 – 0.73 km/km^2 (e.g., Mech et al. 1988).

Scientists have found that wolves select linear features created by human activities associated with trails and road building, oil and gas, mineral exploration and forestry, among others (James & Stuart-Smith 2000, Whittington et al.

2005, Dickie et al. 2017). Similarly, Newton and her colleagues (2017) found wolves across Nakina, Pickle Lake and Cochrane study areas, selected features created by humans as well as natural features such as streams. As described in the caribou section above, these results have implications for caribou conservation since human development of linear features on the landscape increases the efficiency with which wolves can locate caribou dispersed throughout the forest.

In general, wolves require landscape-scale conservation planning based on caribou, moose and beaver populations as well as human disturbance, particularly road densities. At a more local scale, understanding habitat use and protecting areas associated with active wolf dens and rendezvous sites is also needed, including in the Fawn River IPA and KIWDA (e.g., Norris et al. 2002). Eskers may be important for den sites given permafrost and frozen soils and wolves in the Arctic use eskers for traveling, feeding and resting (e.g., McLoughlin et al. 2004). Den sites and rendezvous sites should be protected, spatially and/or temporally, particularly in remote areas like the Fawn River IPA and KIWDA.

Fur returns suggest trends in populations, but these patterns are affected by market prices and trapper effort. Harvest data for wolves are also considered less reliable than for other species because many harvested wolves are not reported, particularly if they are harvested for purposes other than their fur (e.g., nuisance individuals in and around communities) (Ray et al. in Abraham et al. 2011).

At a more local scale, understanding habitat use and protecting areas associated with active wolf dens and rendezvous sites is also needed, including in the Fawn River IPA and KIWDA.

What we know about wolves in the Fawn River IPA and KIWDA

In northern Ontario, scientists have used aerial surveys and radio telemetry to understand wolf distribution and abundance. Wolf densities across the far north region where the Fawn River IPA and KIWDA are located are likely low and a 2009 winter aerial survey, conducted approximately 40 km west of Attawapiskat, calculated 3 wolves/1,000 km^2 (Patterson 2009).

- Kittle and his colleagues (2015) used GPS radio telemetry to study wolf movement and behaviour across the Ontario Shield Ecozone near Nakina (disturbed) and Pickle Lake (undisturbed). Wolf density was estimated at 5.1 wolves/1,000 km^2 throughout the Nakina site and 3.1 wolves/1,000 km^2 throughout the Pickle Lake site (Kittle et al. 2015). Kittle and his colleagues found that wolves adapt their movement behaviours and use of the landscape to the local ecological conditions. For example, at the disturbed site, where relative moose density was higher, wolves disproportionately used areas of high moose abundance. At the undisturbed site, where moose density was lower, wolves selected habitats that allowed them to move more easily (e.g., frozen lakes) and potentially increase their efficiency in encountering moose when they are less abundant. Densities of roads and linear features were considered not to be high enough to influence wolf selection patterns in their study.
- Poley and her colleagues (2014) developed statistical models based on aerial surveys of large mammals during 2009-2011 and found wolf occupancy was related to higher probabilities of occupancy by their prey (e.g., moose, caribou) occupancy (Figure 9).

Importance of wolves

Wolves were once widely distributed across North America and Ontario. Colonizing Europeans however feared and persecuted wolves and in Ontario, this culminated in a bounty on wolves from 1793 through 1972. Wolves are now managed under the Ontario *Game and Fish Act* providing the OMNRF with the authority to establish licences, set seasons for hunting and trapping and regulate harvest, export and trade in wolves.

Lessons learned from both extirpation and restoration of wolves suggests that Indigenous-led conservation and protection in northern Ontario can play an important role in the effort to conserve this species.

Even though wolves have transformative roles in ecosystems, they are still perceived as competitors with human hunters for wild prey such as moose and caribou and managed through depredation programs when they prey on domestic animals such as cattle and sheep. As such, wolves in Ontario largely exist in either protected areas where hunting and trapping are restricted or further north, where prey are available and hunting, trapping and conflicts with humans and their domestic animals are less frequent.

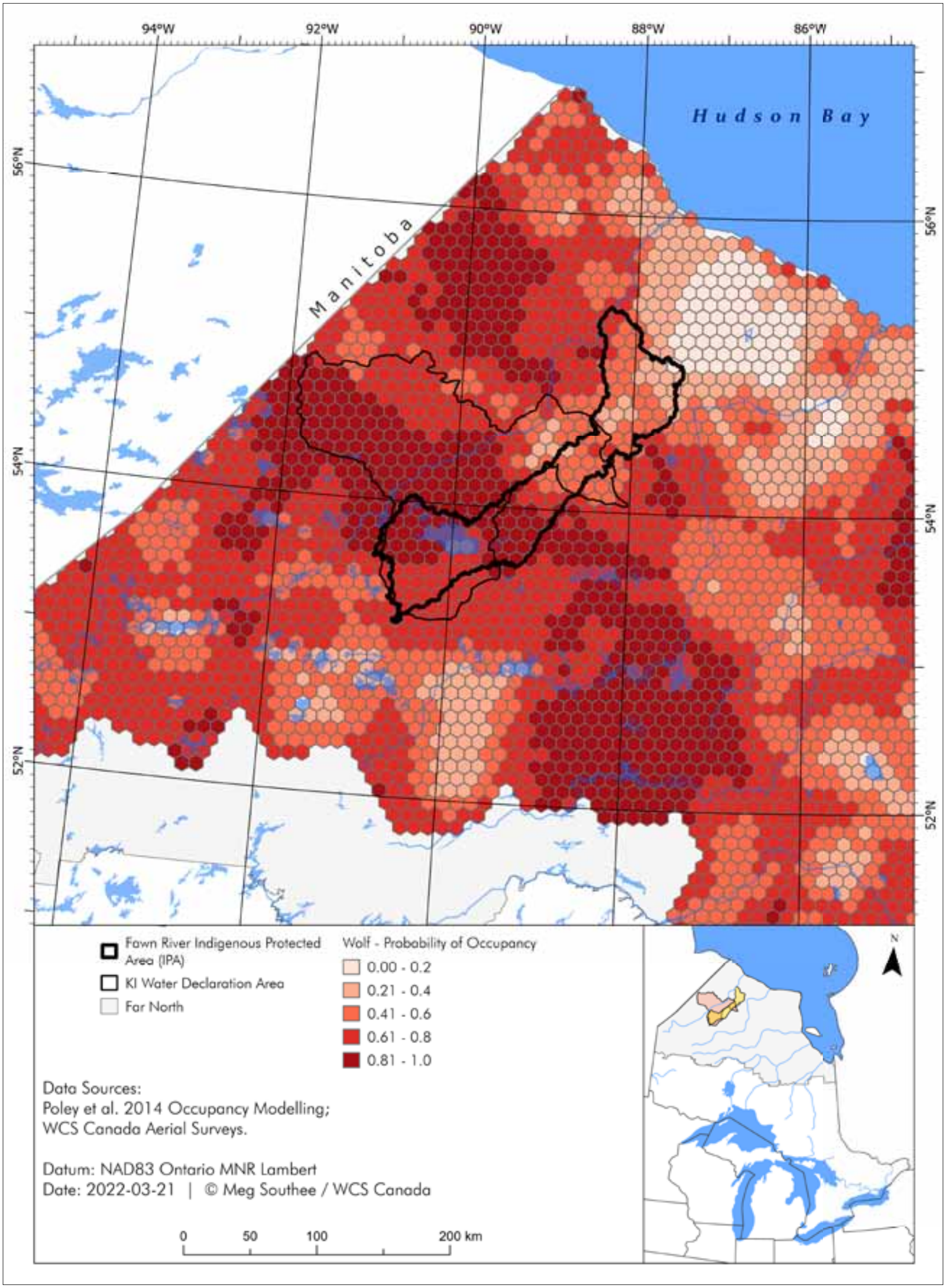
As top predators, the reduction and loss of wolves results in changes throughout terrestrial (and freshwater) ecosystems in ways that are not obvious to scientists and managers. For example, the restoration of wolves to the Greater Yellowstone Ecosystem resulted in a cascade of changes in vegetation creating habitats for beavers, black bears and bison and the return of riparian bird species (Ripple et al. 2014). Lessons learned from both extirpation and restoration of wolves suggests that Indigenous-led conservation and protection in northern Ontario can play an important role in the effort to conserve this species. Research is needed to address the complex socio-ecological challenges of human conflicts with large mammals like wolves.

Much of Ontario's research and conservation efforts to date have been focused on eastern wolves (Benson et al. 2014). While not in northern Ontario, eastern wolves, a unique genetic type of grey wolf, are largely isolated in Algonquin Provincial Park where hunting and trapping are prohibited. Eastern wolves are designated as Threatened under the Ontario ESA and Special Concern under SARA.

American marten, *Martes americanus*

American marten are medium-sized carnivores in the *Mustelidae* or weasel family. They are a habitat specialist in northern boreal forests requiring different resources at different scales (Wiebe et al. 2014). For example, at the landscape scale, marten require large areas of mature and older coniferous and mixed forest for their home ranges (up to 1,600 ha). Marten prefer older and mature coniferous forests and tend not to establish home ranges in areas with > 25-40% early-successional forest due to commercial forestry or development (Potvin et al. 2000). Marten also require complex physical structure including stands of large downed trees, dead wood and declining trees with high canopy closure to protect them from avian predators. Snow cover is important for marten and they select habitat types that provide thermal cover and subnivean (under snow) spaces where prey are active (McLaren et al. 2013). These complex structures support marten foraging for prey and provide protection from the climate (e.g., cold weather and snow) as well as reduce the risk of predation by hawks and other raptors (Bowman & Robitaille 1997).

Figure 9. Average probability of occupancy for wolves, where 0 (light pink) is low and 1.0 (dark red) is high, based on aerial survey data (Poley et al. 2014).



(Credit: Liam Cowan/WCS Canada)

Marten in central Ontario consistently selected for uncut, mature forests and resident animals rarely used adjacent logged forests where they were more susceptible to trapping and predators. Population density and ages of marten were higher in uncut forests due to higher prey populations and fewer predators such as lynx and red fox (Thompson 1994). Thompson (1994) also found the majority of mortality in marten populations was attributed to trapping followed by predators and these rates were higher in logged forests compared to uncut forests. Trapping in uncut forests was a main source of mortality when prey populations were low (e.g., marten had less food). Webb and Boyce (2009) found reduced trapping success was associated with increased industrial activity and areas with greater amounts of open cover on traplines.

Marten populations and habitat preferences depend on the density of marten in the area as well as the density of their preferred prey, which includes red-backed voles, deer mice, red squirrels and flying squirrels (Fryxell et al. 1999). In more western and northern boreal forest ecosystems, marten populations also prey on snowshoe hares and consequently marten, along with lynx, follow cyclical population cycles (Bulmer 1975).

What we know about American marten in the Fawn River IPA and KIWDA

Scientists have used radio telemetry and winter snow-tracking transects, conducted trapper surveys and examined marten carcasses to better understand American marten ecology and behaviour. The majority of studies on marten in Ontario have been conducted in protected areas such as Algonquin Provincial Park or study areas within the AOU. For example, research has focused on habitat selection patterns of American marten living in cut and uncut forests (e.g., Thompson 1994) and the perspectives of trappers and the impacts of trapping on marten populations (e.g., Landriault et al. 2012, Suffice et al. 2017).

Because marten occur at relatively low densities, monitoring these species to determine their population status is challenging. Sales of trapped pelts have long been used by wildlife managers to track fluctuations in the abundance of certain wildlife. However, fur sales can be influenced by population dynamics and trapping efforts, which depend upon numerous social (e.g., employment-trapping conciliation, trappers' health status), economic (e.g., variation in fur prices, available material resources) and environmental (e.g., weather, local habitat disturbance) factors (Suffice et al. 2017).

Importance of American marten

American marten is a Species of Concern in managed boreal forests of Ontario (Watt et al. 1996, McLaren et al. 1998). This is due, in part, to the extirpation of American marten from much of their southern Ontario range in the 1950s because of overharvest and habitat loss due to excessive logging, forest fires and human settlement (de Vos 1952 cited in Abraham et al. 2011). Today, marten populations are considered to have largely recovered. Landriault and her colleagues (2012) noted that American marten remain an economically valuable furbearer in Ontario with an annual provincial harvest by trappers of approximately 40,000 martens.

American marten is a cultural keystone species with important relationships with First Nations and local communities and economies around trapping. For example, American marten has been the most commonly harvested furbearer across the northern region of Ontario since the beginning of the fur trade in the 1600s (Lytwyn 2002).

Scientists consider American marten to be indicators of mature intact coniferous forests and an indicator of sustainable forest management in forests that are commercially harvested (Thompson 1994). The Far North Science Advisory Panel (2010: 85) recommended that the application of "ecological thresholds" for American marten be considered in land-use planning and decision making about development to maintain adequate forest habitats for marten populations (e.g., Hargis et al. 1999).

The Fawn River IPA and KIWDA may provide intact boreal forest for American marten with suitable habitat complexity as well as abundant prey populations of snowshoe hare, red squirrels, southern red-back voles and Ruffed Grouse. Protected areas like the Fawn River IPA where the boreal forest habitat is intact and prey populations are stable or increasing may also serve as a reservoir or source of marten to surrounding areas where American marten may be impacted by trapping, forestry and other human disturbances.

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American beaver, *Castor canadensis*

American beavers are large semi-aquatic rodents best known for their ability to create and maintain wetlands. They affect terrestrial and freshwater systems at multiple scales, making them ecological keystone species of riparian ecosystems (Naiman et al. 1988, Nummi & Holopainen 2014) and are considered ecosystem engineers (Thompson et al. 2021). For example, Stoll and Westbrook (2020) estimated that beaver in Riding Mountain National Park in Manitoba could impound between 8.2 and 12.8 million m^3 of water in comparison to one of the largest hydroelectric dams in Manitoba, Limestone, that has a capacity of 3 million m^3.

Beavers tend to build their dams on fourth order streams or lower, managing variations in water levels primarily through dam and canal building. Beaver dams raise and stabilize water tables, alter stream hydrographs and enhance channel and riparian area sediment retention (Woo & Waddington 1990). The result is hydrologically complex, multi-channel networks that collectively enhance ecosystem resilience to disturbance, particularly climate change (Stoll & Westbrook 2020). Beavers influence terrestrial succession, potentially leading to novel ecosystems, such as beaver wetlands and beaver meadows, with unique habitat characteristics (Whitfield et al. 2015). Beavers and their habitats are natural components of freshwater wetlands across the north and they have co-evolved together suggesting that increasing beaver populations may also increase the future value of the ecosystem services they provide.

Beaver foraging behaviour plays an important role in shaping and linking aquatic and terrestrial ecosystem dynamics in the boreal forest. For example, when beavers are trapped out of ecosystems, forests transition to conifer-dominated stands, which are not palatable to beaver (Green & Westbrook 2009). Beavers depend primarily on deciduous trees in mixed-wood stands, including shade-intolerant trees and shrubs such as aspen, poplar, cottonwood, beaked hazelnut and willow, for food and to create their lodges and dams. Trembling aspen is their preferred food (Touihri et al. 2018) and aquatic vegetation in ponds is important for beaver in sub-Arctic environments similar to the Fawn River IPA and KIWDA (e.g., Milligan & Humphries 2010).

Beavers require food sources to be within, on average, 50 m of their ponds. Greater distances may be possible depending on topography (Touihri et al. 2018), but this also increases the risk of predation (Hood 2020). Fires can renew beaver food sources and densities tend to increase during the first 10-30 years after fire (Touihri et al. 2018). Declines in deciduous food sources due to climate change or land use that affects flooding regimes can potentially affect the ability of beavers to manage wetlands (Stoll & Westbrook 2020).

A baseline survey of beaver activity in the Fawn River IPA, conducted either from a boat or from the air, would be useful to better understand how beavers are maintaining the terrestrial and riparian habitats in the IPA.

American beavers are cultural keystone species and important components of food sovereignty for Indigenous Peoples. Beaver have important cultural and spiritual value to First Nations (e.g., Randazzo & Robidoux 2018). American beavers were nearly extirpated from the continent during the 17th and 18th centuries due to overharvest and trapping (Naiman et al. 1988, Lytwyn 2002). Population recovery began in the 1930s via re-introduction and conservation programs and beavers are one of the most commonly harvested furbearers in this region (e.g., Berkes et al. 1995, Tsuji & Nieboer 1999).

What we know about American beaver in the Fawn River IPA and KIWDA

Scientists in Ontario have studied beaver through aerial surveys, observations and trends in populations evident in trapping and harvest records. However, most of the scientific research on beavers in Ontario has focused on the impacts of forestry and trapping in central Ontario (e.g., Landriault et al. 2009), Algonquin Provincial Park (e.g., Fryxell 2001) and the Chapleau Game Preserve (e.g., Barnes & Mallik 2001).

A baseline survey of beaver activity in the Fawn River IPA, conducted either from a boat or from the air, would be useful to better understand how beavers are maintaining the terrestrial and riparian habitats in the IPA. Interviews with Elders and Knowledge holders may also be useful to better understand the changes happening in the Fawn River IPA because of beaver activity and use.

Importance of American beaver

In addition to their cultural values and ecological roles in engineering ecosystem dynamics and ecosystem services, beavers are an important alternative prey for grey wolves affecting the predator-prey dynamics between wolves, moose and caribou in boreal systems, particularly in the summer (e.g., Latham et al. 2013). Scrafford and Boyce (2018) also found beavers were important prey for wolverine living in the boreal forest. A review of the historical and current trapping information available for beavers would also provide a basic understanding of human impacts on beaver populations over time and possible implications for wolf and wolverine populations.

Bats

Hoary bat (Credit: Jason Headley)

Bats are the only flying mammals in the world and are the second-most diverse group of mammals. Bats can live up to 40 years of age and are efficient and agile predators living primarily on insects, which they catch using echolocation.

Bats are small mammals that have evolved a number of behaviours that allow them to conserve energy, including lowering their metabolism and body temperature daily. Bats also conserve heat and energy by roosting together in specialized habitats during the day and in caves and other structures during the winter. For example, northern long-eared myotis (*Myotis septentrionalis*), little brown myotis (*Myotis lucifugus*), eastern small-footed myotis (*Myotis leibii*), tri-colored bats (*Perimyotis subflavus*) and big brown bats (*Eptesicus fuscus*) hibernate in cool, humid caves or abandoned mines while big brown bats also hibernate in buildings (Naughton 2012). Females of hibernating species give birth in June or July (van Zyll de Jong 1985).

Some bat species migrate south avoiding northern temperatures when insects are not available. Silver-haired bats (*Lasionycteris noctivagans*), eastern red bats (*Lasiurus borealis*), and hoary bats (*Lasiurus cinereus*) migrate between mid-August and October (Fleming & Eby 2003 cited in Layng et al. 2019). Eastern red bats and hoary bats hibernate south of 40°N and in the southern United States and Mexico, respectively (van Zyll de Jong 1985). Females of all migratory species give birth upon returning to the northern parts of their ranges in late May-July. Non-migratory species are affected by white-nose syndrome (WNS) – a devastating fungus affecting their behaviour during hibernation causing death and declines in bat populations across North America (see Diseases in Threats section).

Hoary bats were most frequently detected in their surveys and were the only bat species detected in areas overlapping with the Fawn River IPA and KIWDA.

What we know about bats in the Fawn River IPA and KIWDA

There are eight species of bats documented in Ontario, but bats remain poorly studied by scientists in northern Ontario. As part of the Far North Biodiversity Project, OMNRF conducted a series of surveys for different species in the far north, including bats. The goal of the project was to provide a baseline of information in support of community-based land-use planning. The project conducted acoustic sampling of bats in June and July during 2010–2014. Bat vocalizations were captured using special recorders placed in potential bat habitats.

- Layng and her colleagues (2019) detected big brown bats, hoary bats, eastern red bats, silver-haired bats, little brown myotis, northern long-eared myotis and tri-colored bats during this project. They identified bats by their call signatures and unique species-specific features. Hoary bats were most frequently detected in their surveys and were the only bat species detected in areas overlapping with the Fawn River IPA and KIWDA.

- Layng and her colleagues (2019) found that temperature was a consistent predictor of bat occupancy across the north. Bats required an average daily temperature of at least 14°C for bat occurrence because of the influence of temperature on insects, their primary prey. They also found that forest habitat was an important predictor of bat occupancy because of the unique roosting and foraging habitats that bats require. Finally, they found that some bat species were easier to detect in their surveys such as the little brown bat in comparison to other species like the northern long-eared myotis. Occupancy probability maps developed by Layng et al. (2019) should be requested to support bat research and monitoring in the Fawn River IPA.

Riparian areas and tall, large diameter trees near water could be selected as part of a monitoring program to understand bat occurrence and behaviour in the Fawn River IPA.

Edge and riparian habitats protected within the Fawn River IPA and the KIWDA are likely important habitats for northern bat species because they provide insects and foraging and roosting habitats while offering protection from predation (Gruebler et al. 2008).

Riparian areas in the Fawn River IPA may also provide travel corridors allowing bats to access various habitats as needed throughout their lifetime (Burns et al. 2015). Forest-roosting bats, such as hoary bats, prefer tall, large-diameter trees in stands with open canopies near water (McGowan & Hogue 2016). Riparian areas and tall, large diameter trees near water could be selected as part of a monitoring program to understand bat occurrence and behaviour in the Fawn River IPA.

Ultimately, temperature remains an important predictor of bat occurrence and behaviour in the Fawn River IPA and KIWDA because of its influence on prey (e.g., insects) and the availability of riparian and forest habitats for different bat species that may be present in the Fawn River IPA and KIWDA.

Importance of bats

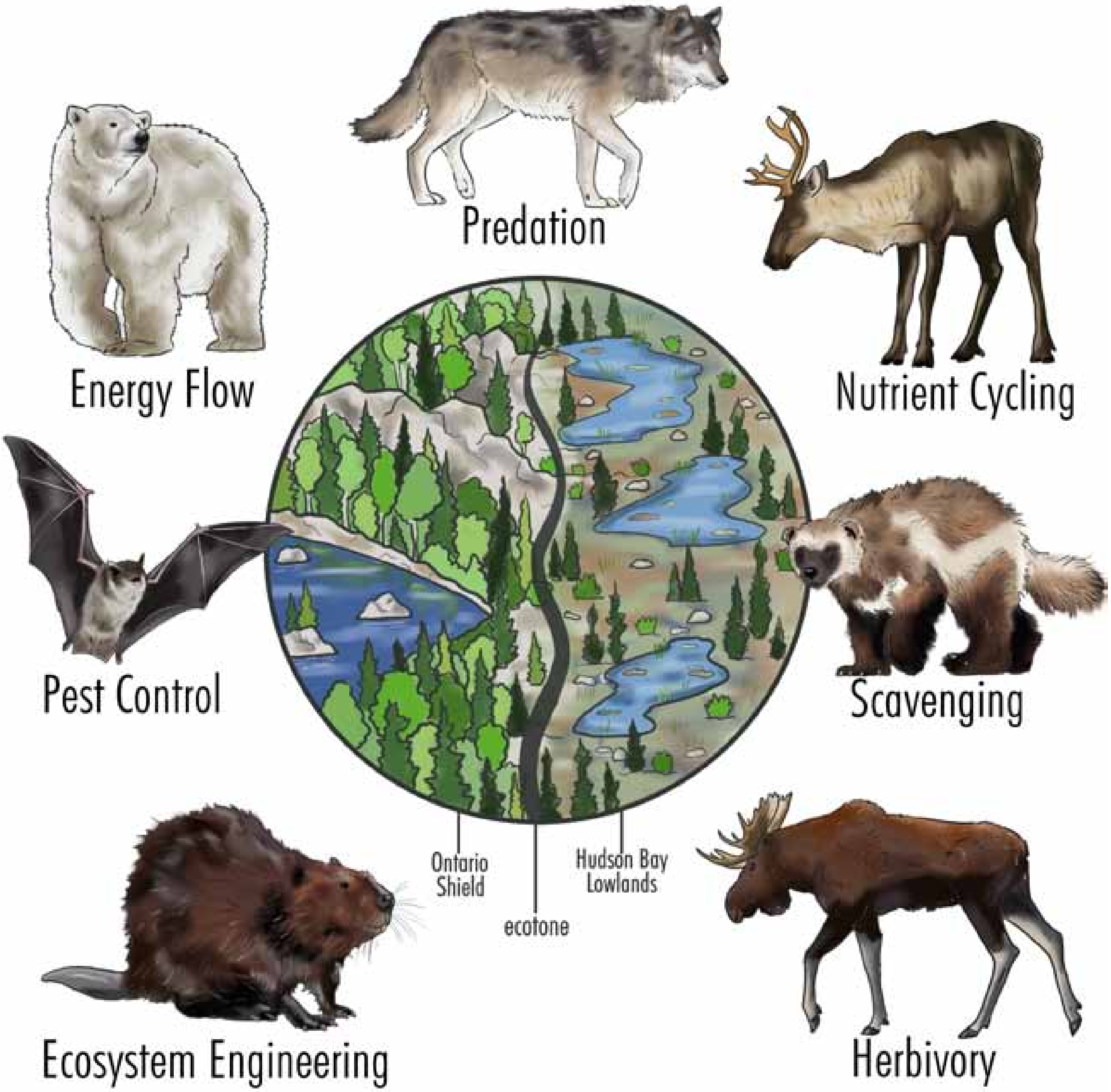
Bats are important indicators of functioning and intact forest and riparian ecosystems and they provide a number of important ecosystem services for humans, including crop pest control and pollination. These are described in more detail in the following section on Benefits to people.

Under the Ontario ESA, the little brown myotis and northern myotis bats are listed as Endangered and are also protected under SARA.

3. Benefits to people provided by the Fawn River IPA mammals and terrestrial ecosystems

Mammals play significant roles in terrestrial, freshwater and marine ecosystems contributing to many ecosystem functions, processes and services. Mammals in the north have important effects on terrestrial ecosystems through nutrient cycling, energy flow and their effects on communities through food-web dynamics, keystone species and bottom-up/top-down ecological processes (Figure 10).

Figure 10. Mammals in the broader region where Fawn River IPA and KIWDA are located play a number of important roles in maintaining the processes and functions of ecosystems. Some of these services are important to people as well. Adapted from Lacher et al. 2019. (Credit: Lucy Poley)



Large herbivores like caribou and moose and top predators like wolves and wolverine influence ecosystems at many levels through the consumption of vegetation and prey, respectively. (Ripple et al. 2014). These relationships can have profound effects on riparian vegetation and animal communities using these habitats. Bats are important pollinators of plants, disperse seeds and consume insects such as mosquitoes (Kunz et al. 2011). Beavers are considered ecosystem engineers that create, modify or destroy habitats that alter ecosystem structure and function and increase biodiversity (Thompson et al. 2021).

Many mammals and boreal plants within terrestrial ecosystems like those in the Fawn River IPA are the foundation for food sovereignty and medicines for First Nation communities with important cultural and spiritual values and social practices within Indigenous Knowledge Systems (e.g., Karst 2010).

Protecting mammals within the Fawn River IPA and KIWDA supports the maintenance of ecosystem services that are important to KI, First Nations, Ontarians, Canadians and the world. Some of these services are identified in Appendix 1. Completing an ecosystem services assessment (e.g., Ecosystem Services Toolkit) in the Fawn River IPA and KIWDA would help identify relevant ecosystem services in the region and identify research, monitoring and communication about the value and importance of Indigenous-led protected areas to conserve mammals.

Mammal declines and losses compromise the functions they have in ecosystems and the services they provide that benefit humans.

4. Threats

Mammals are severely impacted by habitat loss, overharvest, invasive species and climate change (Schipper et al. 2008, Pacifici et al. 2017). Mammal declines and losses compromise the functions they have in ecosystems and the services they provide that benefit humans (Lacher et al. 2019). At the same time, humans, also mammals, have been described by scientists as a "hyper keystone" species (Worm & Paine 2016) because they have transformed the land, water, atmosphere and biodiversity of the planet (Barnosky et al. 2012).

Where humans have used energy, extracted largely from fossil fuels, to develop industrial agriculture, roads and cities to create global infrastructure supporting a connected economy, there have been pervasive impacts that threaten all mammals, biodiversity and life.

The following section describes some of the key threats to mammals in northern boreal and taiga biomes similar to the Fawn River IPA and KIWDA.

Direct mortality of mammals

Wildlife trapping and harvest in the far north in Ontario is mainly by First Nations people. Harvest of wildlife by First Nations is recognized as the basis of inherent, Treaty and Aboriginal Rights.

- In the HBL portion of the Fawn River IPA and KIWDA, harvest estimates for all groups of wildlife including furbearers, caribou and moose were determined in the early 1980s (e.g., Berkes et al. 1995). With few exceptions, most species are not currently being monitored adequately or at all and require different protocols and sampling rates to determine status and detect trends in populations. For example, the frequency of aerial population surveys for moose and caribou is greater in the southern Ontario Shield portion of the far north (3-5 year cycle) than it is in the northern HBL portion (about a 10-20 year cycle) while furbearers are monitored at the scale of registered traplines (tens to hundreds of square kilometres).

- Within the region, new and planned infrastructure associated with the Ring of Fire mineral exploration area could also result in increased access and harvesting rates and mortality associated with wildlife conflicts and vehicle collisions affecting many large mammals as they move to avoid the disturbance associated with all-weather roads and mines.
- Another area of mortality for mammals is through human-wildlife interactions and conflicts including at landfill sites, exploration and mining sites and other developments. These sites may be associated with increased potential for purposeful or incidental harvest of "nuisance wildlife" particularly carnivores such as polar bears, grey wolves, foxes and wolverines (Nyhus 2016).

Community-based monitoring of mammals, including human-wildlife conflicts, threats and harvest in the Fawn River IPA and KIWDA is important for understanding the status and trends of mammals as well as demonstrating the importance of Indigenous-led conservation and protected areas to mammal conservation in northern Ontario.

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Climate change

Human-induced climate change is an important threat contributing to cumulative impacts on mammals in the Fawn River IPA, KIWDA and throughout the region.

The impacts on mammals will depend on the species. For example, a shorter sea-ice season in Hudson Bay and James Bay will negatively affect polar bears who depend on sea ice to find their preferred food (Varrin et al. 2007) and warmer temperatures may reduce suitable habitat for caribou because of insect harassment (Vors & Boyce 2009). Changes in snow depth and snow persistence will affect current relationships between wolverine (Copeland et al. 2010), lynx and snowshoe hares and their winter and spring habitat requirements. However, some northern species may also benefit from climate change. For example, an increase in forest fire frequency could generate younger forest stands and additional suitable moose habitat (e.g., Rempel et al. 1997) while warmer winter temperatures may lead to northward expansion of bats (Sherwin et al. 2013). Beaver will have an important role in maintaining the resiliency of the boreal forest to climate change. Yet, increases in the occurrence and severity of wildfires, for example, will also change the vegetation composition of boreal forests in ways that may not be ideal for beavers (Hood & Bayley 2008).

Climate change will interact with and exacerbate other threats and stressors, including habitat loss and fragmentation, overharvest, invasive species and pollution. The result will be direct, indirect and cumulative impacts on both terrestrial ecosystems and the mammals that depend upon them (McCain & Heske 2019).

Looking forward, the climate future of the Fawn River IPA and KIWDA is expected to be warmer and will alter the water cycle, including the precipitation to evaporation regime causing changes in streamflow. As such, establishing a baseline of information will be important for determining how these changes may impact the Fawn River IPA including measuring weather and climate variables to understand how the IPA and broader region are changing.

Current and future land use

Existing and proposed land use such as hydroelectric, mineral exploration and mining projects, electricity transportation corridors and winter and all-season roads can contribute to direct, indirect and cumulative effects on caribou and other mammals in the region.

Eskers should be identified as ecologically sensitive and monitoring programs should include detailed investigations of any wildlife use associated with eskers in the Fawn River IPA and KIWDA.

These developments enable hunters and predators to access caribou and moose more easily and create barriers to their movement. For example, the winter road from Shamattawa to Fort Severn as well as ATV travel along the coast in the summer may have already impacted caribou, affecting population distribution and abundance in the Fawn River IPA and KIWDA.

As industrial development in the region progresses, eskers will likely be identified as a source of granular material for road and mine construction. However, eskers make up a relatively small percentage of the landscape and the importance of eskers for wildlife remains poorly documented in northern Ontario. For example, Arctic research has found an association between wolves and the use of eskers for denning habitat (McLoughlin et al. 2004). Eskers should be identified as ecologically sensitive and monitoring programs should include detailed investigations of any wildlife use associated with eskers in the Fawn River IPA and KIWDA.

Wildlife health

Pathogens are living or non-living things capable of causing disease in living organisms (Leighton 2011). Pathogens are part of the biological and environmental complexity that lends stability and resilience to ecosystems and their functions. Living pathogens make up the biodiversity of ecosystems, including a wide spectrum of organisms, from worms and arthropods, to fungi, protozoa, bacteria and viruses.

Non-living pathogens include simple chemical elements like mercury; a wide range of industrial and other chemicals produced by humans (called Contaminants below); complex biological toxins produced by various organisms; and misfolded proteins such as the prions responsible for the transmissible spongiform encephalopathies including chronic wasting disease (CWD).

Scientists recognize that the occurrence, intensity and importance of disease in individual mammals and their populations are governed by many influences including the physiology (e.g., nutrition, diet, age, sex, health) and population dynamics of the species, individual exposure to pathogens, and the condition of the environment such as temperature, moisture, salinity and pH.

The patterns of disease in wild mammals has changed profoundly with escalating environmental change and some pathogens are of national and international concern because they can cause disease in humans, or zoonoses (e.g., Keatts et al. 2021), and domestic animals or threaten wild populations around the world.

National surveillance of wildlife health in Canada is carried out by the Canadian Wildlife Health Cooperative (CWHC n.d.). Some of the more common and important pathogens of wild mammals are highlighted below. Please check out the CWHC website for more information on these pathogens.

- **Rabies (virus).** Rabies is a fatal infection of the central nervous system caused by any of the several different strains of rabies virus, a rhabdovirus. It is transmitted from infected to uninfected animals, including humans, primarily by bite wounds contaminated with infectious saliva. All mammals appear to be susceptible to all strains of rabies virus, but each strain persists in nature by transmission cycles within a single host species or a very small group of host species. For example, strains of rabies virus maintained in Arctic foxes and in several different species of bats appear to have been present in Canada since prehistoric times.
- **Brucellosis (bacteria).** Brucellosis is the name given to all diseases caused by infection with any of the several different species of the bacterial genus *Brucella*. The clinical manifestations of brucellosis are many, but the most common are infection and inflammation of the female and male reproductive tracts with resulting abortion and male infertility, and infection of joints and tendon sheaths resulting in progressive lameness. Infection persists often for the lifetime of the animal. Humans are similarly susceptible to infection. Brucellosis is currently limited to bison in and around Wood Buffalo National Park, barren-ground caribou across northern Canada and in seal populations.
- **White-nose syndrome (mainly fungus).** White-nose syndrome (WNS) is a new disease that was first recognized in bats in New York State in the winter of 2006. The first occurrences of WNS in Canada were detected in the late winter of 2010 during active surveys of bat hibernacula in Ontario and Québec (COSEWIC 2013). Affected individuals suffer severe weight loss and dead and dying emaciated bats have been found outside of major hibernacula during late winter, presumably searching for food when none is available and the bats should be hibernating. White-nose syndrome is thought to be the leading cause of decline of bat species in Ontario (COSEWIC 2013).
- **Meningeal worm of white-tailed deer (parasitic worm).** *Parelaphostrongylus tenuis* is a parasitic brain worm of white-tailed deer with a life cycle that involves two very different animal hosts: the white-tailed deer and several different species of terrestrial snails and slugs. The adult worms live in the connective tissue membranes on the outside of the brain (the meninges) of the deer where they mate and deposit eggs into the deer's large veins. The

eggs are carried to the lungs where larvae then hatch. The larvae move up the airway to the throat, are swallowed, and then expelled in the deer's feces. The infectious larvae then burrow into snails and slugs, which, in turn, excrete them. These excreted infectious larvae are consumed by deer and move into the deer's brain and spinal column (Lankester, 2010). In white-tailed deer, the adult worms live on the surface of the brain for the lifetime of the deer without causing significant damage or disease. However, in moose and caribou, *P. tenuis* can produce fatal disease. Movement of white-tailed deer further north in Ontario as climate change (e.g., Kennedy-Slaney et al. 2018) make habitats more suitable for them could change the distribution of *P. tenuis* with implications for caribou and moose where they overlap (e.g., Rempel et al. 2021).

- **Winter tick in moose (parasitic insect).** Throughout most of their range in North America, moose suffer periodic events of high mortality in late winter associated with severe infestations with winter tick, *Dermacentor albipictis*. This tick is native to North America and infests a variety of other hosts including caribou. However, severe infestations frequently resulting in death are common only in moose. Large-scale mortality events often are described in association with weather events such as severe cold, snow or freezing rain in March and April, impacting moose affected by inadequate nutrition from poor habitat. Infections of winter ticks are expected to increase with climate change (e.g., Rempel et al. 2021).
- **Chronic wasting disease (infectious proteins or prions).** Chronic wasting disease (CWD) is a fatal prion disease of the brain of deer, elk and moose and is spreading in North American cervid populations (Mysterud & Edmunds 2019).

Contaminants

Many contaminants including PCBs and organochlorine pesticides such as dichlorodiphenyltrichloroethanes (DDTs), chlordanes (CHLs), hexachlorocyclohexanes (HCHs) and hexachlorobenzene (HCB) used in industry and agriculture have been regulated in some countries at national level since the 1970s. Since 2004, these contaminants have been regulated globally by the Stockholm Convention on Persistent Organic Pollutants (UN Environment Program 2019) yet they are still present in high concentrations in Arctic and some sub-Arctic environments, particularly marine ecosystems. Generally, mercury pollution is considered to be a consequence of nonpoint source global emissions. Mercury emissions have recently been subject to regulation at the international level through the 2017 ratification of the Minamata Convention on Mercury.

Apex predators such as polar bears and wolves can bioaccumulate these contaminants over time as a result of eating prey animals that also contain contaminants ingested during their lifetimes. Contaminants can disrupt their immune systems, endocrine functions and reproduction, emphasizing the need for continued monitoring. Polar bears remain the most well-studied mammal in the region with respect to contaminants (Routti et al. 2019). Polar bears in the South Hudson Bay subpopulation have been found to have high concentrations of a number of fat-soluble contaminants used as insecticides in industrial agriculture, including chlordane-related compounds, dichlorodiphenyldichloroethylene (DDE, the degraded version of DDT), and dieldrin (an alternative to DDT) (Norstrom et al. 1998). Changes in diet due to climate change may also expose polar bears to additional contaminants (Thiemann et al. 2008).

Many metals such as mercury, lead and arsenic occur naturally in the region and may be increased by human activities such as mineral exploration, road building and mining. Concentrations of 21 elements measured from Canadian polar bears (including the South Hudson Bay subpopulation) have not changed significantly since the 1980s, and all levels within the South Hudson Bay subpopulation were below those associated with toxicity effects (Rush et al. 2008).

To address contaminants and potential implications for human and wildlife health, measurements and modeling will be necessary and baseline sampling from hunter-killed mammals would be useful to better understand current levels of contaminants in mammals in the Fawn River IPA and KIWDA.

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Interactive and cumulative effects (see also Climate change)

Conserving mammals requires a comprehensive approach that can consider cumulative effects. Cumulative effects are often characterized as "death by a thousand cuts" referring to the perceived individual activities that are assessed in isolation but contribute to major impacts when combined or interacting with other activities (MacDonald 2000). A recent report by the Council of Canadian Academies (CCA 2019) on natural-resource management argues for land-use management that occurs at relevant ecological and social scales and addresses cumulative effects more explicitly as part of the management, rather than in isolation within impact assessment.

Mammal conservation and the consideration of cumulative effects in Ontario are almost impossible under Ontario's current policy and siloed approaches to land-use planning and decision making. Protected areas like the Fawn River IPA will be important as development unfolds across northern Ontario.

Previous recommendations have called for careful planning of development and implementation needs to be monitored over time and adapted as necessary (e.g., FNSAP 2010). Industrial development like roads, mines and hydroelectric development, among others, are novel stressors on the ecosystems and species in the north.

Where possible, potential ecological thresholds based on the best available science and Indigenous Knowledge should be considered. Enough is known about certain responses to suggest precautionary limits to human activities that may contribute to the total amount of landscape disturbance on boreal caribou populations (e.g., Environment Canada 2012).

Ecological thresholds that may be relevant at the scale of the Fawn River IPA include:

- **Habitat loss.** Species like American marten require interior forest conditions and are unable to persist in landscapes with intact habitat patches that are below a certain size (FNSAP 2010).

- **Overall disturbance.** Disturbance-sensitive species such as caribou may exhibit recruitment failure once a certain percentage of their population range has been disturbed through natural and anthropogenic sources (Environment Canada 2012).
- **Roads.** A number of species like wolves and wolverine may be unable to persist in landscapes characterized by critical density of roads (Mladenoff et al. 1995) or they may move away from roads due to disturbance resulting in functional habitat loss (e.g., caribou) (Vors et al. 2007).

As Ontario and First Nations communities develop all-season roads, transmission lines and broadband communications, there will be increasing region-opening development requiring a proactive, comprehensive strategic plan for transportation and energy. While Ontario is planning to develop an all-season road strategy for the far north, limits on road density, water crossings and wetland incursion should be developed to minimize risks to mammals and the communities that depend upon them.

While Ontario is planning to develop an all-season road strategy for the far north, limits on road density, water crossings and wetland incursion should be developed to minimize risks to mammals and the communities that depend upon them.

5. Recommendations

Terrestrial ecosystems

- Consider more carefully, the approaches to commercial forestry management and planning in the northern remote regions where productivity and growing seasons are short and there are multiple social and ecological values besides timber and employment.
- Designate eskers as ecologically sensitive and include detailed investigations of any wildlife use associated with eskers in the Fawn River IPA and KIWDA as part of monitoring programs.

Mammals

- Monitor land use within the IPA to ensure impacts to caribou do not increase at the range scale.
- Co-create research with First Nations to address the lack of scientific information on moose population dynamics, distribution and relationships to First Nations in the Fawn River IPA and KIWDA.
- Conduct research to understand habitat use and protect areas associated with active wolf dens and rendezvous sites in the Fawn River IPA and KIWDA.
- Conduct a baseline survey of beaver activity in the Fawn River IPA to better understand how beavers are maintaining the terrestrial and riparian habitats in the IPA.
- Review historical and current trapping information available for beaver to develop a basic understanding of human impacts on beaver populations and possible implications for wolf and wolverine populations.

- Conduct interviews with Elders and Knowledge holders to better understand the changes happening in the Fawn River IPA because of beaver activity and use.
- Monitor riparian areas in the Fawn River IPA for bat presence and activity.
- Request occupancy probability maps developed by Layng et al. (2019) to support bat research and monitoring in the Fawn River IPA.
- Complete an ecosystem services assessment (e.g., Ecosystem Services Toolkit) in the Fawn River IPA and KIWDA to help identify relevant ecosystem services in the region and identify research, monitoring and communication about the value and importance of Indigenous-led protected areas to conserve mammals.
- Collect samples from hunter-killed mammals to better understand current levels of contaminants in mammals in the Fawn River IPA and KIWDA.

Fawn River IPA management and planning

- Establish protocols and best practices to support the use of Indigenous Knowledge Systems and science to provide the best available knowledge to consider the past, current and future conditions of mammals and the ecosystems they are interconnected with.
- Given the cumulative effects of land use and climate change, further research and monitoring led by the community should be explicitly included in planning and decision making about the biodiversity and ecosystems that make up the Fawn River IPA.
- Develop a community-based monitoring program in the Fawn River and KIWDA, including human-wildlife conflicts, threats and harvest to support the understanding of the status and trends of mammals.
- Establish a baseline of information, including measuring weather and climate variables, to determine what is changing and how these changes may impact the Fawn River IPA.
- Establish limits on road density, water crossings and wetland incursion to minimize risks to mammals and the communities that depend upon them.
- Demonstrate the importance of Indigenous-led conservation and protected areas to mammal conservation in northern Ontario.

Further information

[1] While the Fawn River IPA is not directly connected to the marine ecosystem of Hudson Bay, polar bears are included in this section. Additional information about the importance of marine mammals, including five species of whales, five species of seals and Atlantic walrus are described in Niemi and her colleagues (2010).

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7. Appendix

Appendix 1. Ecosystem Service Descriptions and examples of mammals and terrestrial ecosystems that potentially provide these services in the Fawn River IPA and KIWDA. Descriptions of each Ecosystem Service are taken from the 2017 Value of Nature to Canadians Study Taskforce. *Note: This table does not include cultural services and defer to the KI Cultural Atlas for a preliminary understanding of the cultural value of mammals to KI.*

Ecosystem service (ES) and how benefits to humans are derived from the ES	Potential example of ES provided by mammals in the Fawn River IPA and KIWDA
Provisioning services – the result of ecosystem processes and functions that provide goods or products	
• Food Edible products derived from plants, animals and fungi that humans require for biological sustenance or commercial use (e.g., fruits, nuts, seeds, meat, vegetables, fungi, tubers/roots, herbs, oils). Ecosystems produce many wild foods and also provide soil, nutrient, microbiological and climatic conditions that enable humans to cultivate food. These occur through natural gross primary production and conversion of solar energy into biomass, secondary productivity through energy transfer in food chains and water and nutrient cycling.	Many mammals are important food sources for First Nations in northern Ontario and are culturally significant for food security and sovereignty. Some mammals like moose are also important food sources for recreational and non-Indigenous hunters in Ontario. Domesticated mammals are the basis for much of the protein in human diets in North America.
• Timber and other wood products Ecosystems produce raw materials from plants and animals that are used by people in many different ways. Plant fibres are used for building (e.g., wood) or are broken down for other products (e.g., pulp for paper) and are also woven to make fabric and other pliable materials (e.g., rope). Raw material derived from animals is also used by people (e.g., fur and wool for clothing, blankets and other textiles, down filler and sinew for a variety of purposes).	Boreal-forest ecosystems that provide homes and habitats for many species of mammals provide timber for harvest as well as biomass fuel in Ontario.
Ecosystem service (ES) and how benefits to humans are derived from the ES	**Potential example of ES provided by mammals in the Fawn River IPA and KIWDA**
Regulating services – the result of ecosystem processes and functions that regulate all aspects of the environment, providing security and habitable conditions that species, including humans, rely upon	
• Pollination and seed dispersal Most plants require pollination to reproduce. Natural pollination occurs primarily by insects and also by wind, birds, and bats. Changes to ecosystems and impacts to pollinator species from human or other activity alter the abundance and distribution of pollinators and hence their effectiveness.	Pollination and seed dispersal is an example of a mutually beneficial relationship between plants and mammals in which mammals are mobile links between plant populations in terrestrial ecosystems. Many fruit- and seed-bearing plants have co-evolved with their fruit-eating seed dispersers including browsing moose and caribou, scatter-hoarding rodents such as red squirrels and some bat species.
• Insect pest regulation Changes to ecosystems, including pest management interventions, can alter the capacity of the ecosystem to naturally regulate pests, thus potentially influencing the production of harvestable goods. Natural pest regulation supported by healthy ecosystems significantly reduces impacts of unwanted predation, for example, on crops, and the monetary and (in the case of pesticide use) health costs associated with implementing engineered controls.	The consumption of large numbers of night-flying insects by bat populations has been quantified by scientists studying bats and agriculture in the United States.
• Water purification and water treatment Vegetation, soils and soil biota can help to filter out and sequester or decompose organic wastes, including those introduced in production landscapes. Water filtering by wetlands involves the breakdown of nutrient-rich waste from human and animal sources and the removal of disease-causing bacteria such as *E. coli*. Bioremediation of soils and water relies on the metabolic activity of plants and microorganisms to absorb pollutants from soil or water and, in some cases, to digest toxins. The purification of fresh water for drinking and other purposes as well as the removal of microbes and other toxins provide an important benefit to human health.	Boreal-forest ecosystems can affect freshwater quality. For example, forests along water edges and riparian features provide shade, moderating water temperatures and provide a source of organic nutrients used by fish and other aquatic organisms that are eaten by mammals. Processes like wildfire, blowdown and erosion provide sediment, nutrients and increase water temperatures. Forests also modify the chemistry of incoming precipitation as a result of interactions between vegetation and soils. Intact boreal forests in watersheds like the KIWDA are able to maintain high-quality drinking water.

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Ecosystem service (ES) and how benefits to humans are derived from the ES	Potential example of ES provided by mammals in the Fawn River IPA and KIWDA
• Climate regulation and carbon sequestration Ecosystems play an important role in moderating local weather and influence climate locally, regionally and globally. Ecosystems influence global climate by emitting greenhouse gases (GHGs) or by absorbing GHGs or aerosols from the atmosphere. Topography, vegetation, decomposition (by animals, fungi and microbes), albedo and waterbodies interact with regional and global climate processes to regulate climate.	Boreal-forest ecosystems in northern Ontario are important for storing and sequestering GHGs and carbon for the purposes of climate change mitigation. Maintaining this service requires intact mature forests, enabling the forest to recover post-impacts and/or restoring damaged and degraded ecosystems. Beavers modify GHG storage and sequestration dynamics. Beaver activity in creating and maintaining wetlands causes both sink and source dynamics of carbon and methane, which vary due to the temporal and spatial nature of beaver occupancy, along with dam/flood/pond age and water table level. A single beaver wetland may simultaneously both sequester and emit GHGs if several beaver works are concurrently present (e.g., a dry beaver meadow and a deep inundation area).
• Natural hazard regulation The impact of extreme weather events and natural hazards such as floods, avalanches and landslides can be ameliorated by intact ecosystems. For example, coastal dune ecosystems can dampen the impact of storm surges, thus minimizing harm to people and damage to infrastructure. Ecosystems also play a role in regulating natural disturbance regimes such as forest fires. Changes to forest ecosystems, for example, through fire suppression, can lead to more intense fires caused by higher fuel loads that can damage seed banks and be more difficult to control.	Beavers help moderate the impacts of extreme weather events affecting water flow and levels. Beaver-created wetlands modify natural-flow regimes by increasing surface- and groundwater retention, thereby moderating extreme events. Flood peaks are mitigated through rainwater retention and drought conditions by slowly releasing water through dams.
Ecosystem service (ES) and how benefits to humans are derived from the ES	**Potential example of ES provided by mammals in the Fawn River IPA and KIWDA**
Supporting or habitat services – the underlying ecosystem processes and functions that are necessary for the production of all other ecosystem services, creating the biological environment	
• Primary production, energy flow and nutrient cycling	Large herbivores, including moose and caribou, that graze and browse vegetation throughout the year and either migrate or move between freshwater and terrestrial ecosystems play important roles in transferring nitrogen, phosphorus and other important nutrients across boreal forests and taiga biomes. For example, grazing by migratory caribou herds shifts dominant lichen-bryophyte communities to grasses and sedges. Preferences of these species for different shrubs influence which plants dominate, particularly as climate impacts plants as well. Declining populations of caribou and moose likely have important implications for boreal-forest and taiga productivity in northern Ontario.
• Habitat Habitats provide everything that an individual plant or animal needs to survive: food, water and shelter. Each ecosystem provides different habitats that can be essential for a species' life cycle. Migratory species, including birds, fish, mammals, and insects, all depend upon multiple ecosystems during their migrations.	Beavers affect the environment providing shelter, food and breeding habitat for invertebrates, fishes, amphibians, waterfowl and other mammals.

6. PEATLANDS OF THE FAWN RIVER INDIGENOUS PROTECTED AREA

Top, Sphagnum moss hummocks and pools in a bog. Bottom, Round-leaved sundew (Drosera rotundifolia) and Sphagnum moss (Sphagnum rubellum) (Credit: Lorna I. Harris/WCS Canada)

Prepared by Lorna I. Harris, Wildlife Conservation Society Canada

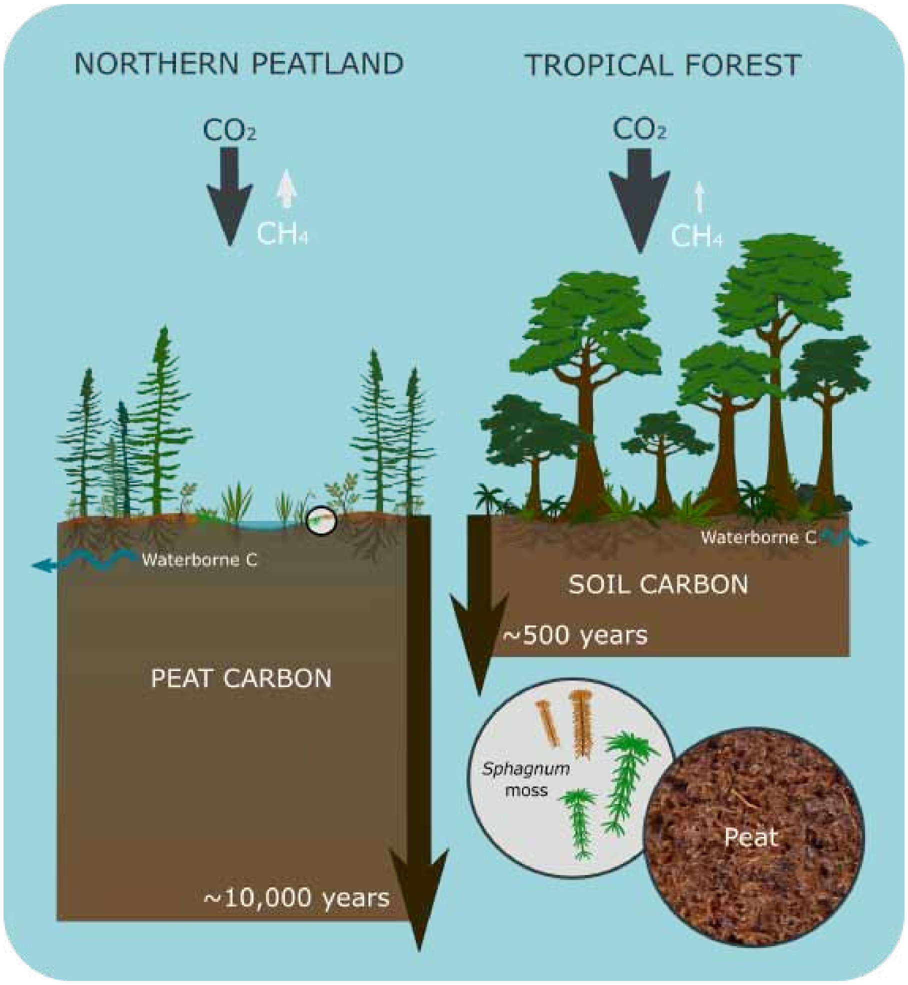
1. Introduction

What are peatlands?

Peatlands are ecosystems with waterlogged ground, which prevents plant material from fully decomposing. Over thousands of years, this dead organic matter gradually accumulates to form deep peat soils that are rich in carbon. Although surface vegetation varies in different climates, from the tropics to northern latitudes, peatlands develop in the same way, with plant production exceeding decomposition.

On the surface, northern peatlands are covered in diverse plant species, from dense and somewhat stunted canopies of black spruce trees (*Picea mariana*), to more open landscapes of low-lying shrubs, sedges and open water pools. One of the smallest, and arguably most important plants in northern peatlands, is *Sphagnum* moss. Forming a soft and gently undulating carpet of raised hummocks and hollows across the peatland surface, *Sphagnum* moss is critical for the formation of many peatlands (Turetsky et al. 2012). Often described as a bog builder, the living tip of the moss continually grows upwards, while the lower sections are slowly added to the underlying peat. As decomposition is slow and *Sphagnum* moss is itself resistant to decay, the species of moss fragments that make up the peat soil are often easily identified, even in deeper peat (Figure 1).

Figure 1. Simplified diagram of carbon storage in northern peatlands and tropical forests.



Most peatlands dominated by *Sphagnum* moss are solely dependent on rain or snow as a water source, resulting in nutrient-poor conditions. As these bogs are also acidic (pH typically less than 4.5; Clymo 1964), only specialist wetland plants can thrive, including the carnivorous pitcher plant (*Sarracenia purpurea*) and sundew (*Drosera* sp.). Peatlands fed mostly by groundwater are called fens and usually have a greater diversity of shrubs and herbs than bogs due to the increased availability of nutrients. *Sphagnum* moss is a common feature of many fens, but many other moss species – termed true or brown mosses – are also abundant. These moss species are more tolerant of alkaline waters in fens and are good indicators of peatland water chemistry.

Why are peatlands important?

Peatlands are the world's largest and most dense land-based carbon stores (see Box 1). Peatlands cover only 3% of Earth's land surface but contain more than 550 billion tonnes of carbon, which is between 20-30% of the world's total soil carbon (Yu et al. 2010, Scharlemann et al. 2014). In contrast, tropical forests store around 470 billion tonnes of carbon but cover nearly 40% of Earth's land surface (Pan et al. 2011).

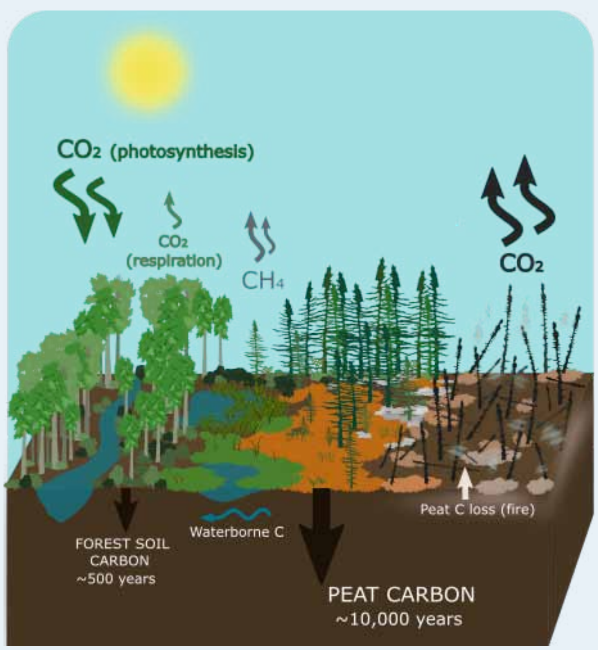
Box 1. What is carbon and how is it measured in peatlands like the HBL?

What is carbon?

Carbon (C) is a critical element for all life on Earth, found in rocks, soils, the oceans, rivers, lakes, plants and animals. In the atmosphere, C is mostly in the form of carbon dioxide (CO_2), a greenhouse gas (GHG) that traps heat close to the earth. Plants and other vegetation (e.g., lichens, algae) remove CO_2 from the atmosphere and store it in leaves, tissues, branches and roots as biomass C. As the living biomass dies, this C is released back to the atmosphere, slowly added to the soil (as soil C) or transferred to other C pools. This is known as the carbon cycle (Figure 1).

Peatland ecosystems are a persistent long-term terrestrial C store, with the wet conditions slowing the decay of dead vegetation that gradually accumulates to form deep peat soils that are rich in C. Almost 30% (550 billion tonnes) of the world's total soil C is stored in peatlands, which cover only 3% of Earth's land surface[1,2]. In contrast, tropical forests store around 470 billion tonnes of C, but cover nearly 40% of Earth's land surface[3].

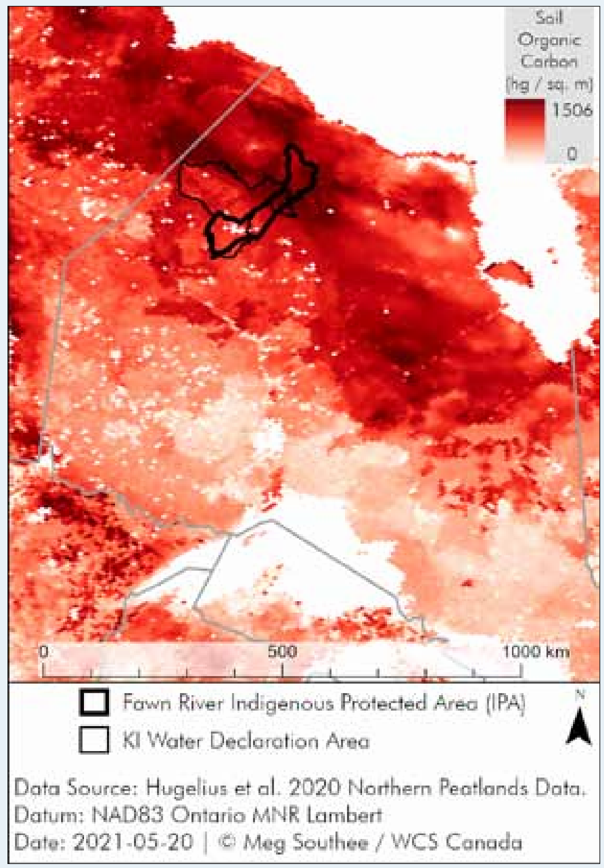
Figure 1. The carbon cycle is a biogeochemical cycle that exchanges carbon in a number of different forms among all the parts of Earth including the geosphere, biosphere and atmosphere.



Why is carbon important?

Humans have significantly increased the amount of CO_2 in the atmosphere, through the burning of fossil fuels and the conversion of forests, peatlands and other ecosystems to other land use (e.g., agriculture). These increased emissions have caused global temperatures to rise and cutting emissions of all GHGs is now a priority to prevent dangerous climate impacts. Along with reductions in industrial emissions, preserving and restoring natural C sinks, including peatlands, is recognized as critical to prevent rapid and dangerous global climate warming[4,5]. For thousands of years, peatlands have removed CO_2 from the atmosphere and stored this C in peat soils, effectively cooling the global climate[6] (Figure 2). It is essential that peatlands continue to function as effective C sinks, and that the C stored within them remains there.

Figure 2. The soil carbon estimated across the far north including the Fawn River IPA and the KI Water Declaration Area.



How do we measure carbon in peatlands?

The amount of C stored in peat soils is measured by taking cores of peat from the surface of the peatland through to the underlying sediment or bedrock. The C content and bulk density of small sections of the peat core are determined through laboratory analyses so that the total amount of peat C stored within the core can then be calculated. The total amount of peat C stored in a peatland or across a region is calculated using data from multiple peat cores to ensure the spatial variability in peat properties and peat depth are represented[7].

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To determine the strength of the peatland C sink (or if the peatland is a C source to the atmosphere), emissions or fluxes of GHGs (CO_2, methane – CH_4, nitrous oxide – N_2O) from the surface of the peatland are needed. GHG fluxes from peatlands are measured using closed chambers that trap the air above the surface of the peatland for a very short period[8], or using sensors on small towers that continuously measure the concentrations of GHGs in the air above peatlands[9]. Measurements of waterborne C in streams, rivers and lakes within peatland landscapes may also be used to help determine the net C balance of a peatland. For permafrost peatlands, measurements of depth of surface thaw and peat temperatures are used to monitor the rate of permafrost thaw, which impacts peat C stores and the C sink function of the peatland[7].

Top, a closed chamber method for measuring and monitoring greenhouse gas fluxes, including CO_2. Bottom, an Eddy Covariance Flux Tower for monitoring CO_2, water vapour and other gases. (Credit: Lorna I. Harris/WCS Canada)

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Peatlands are also a persistent long-term carbon store. For thousands of years peatlands have removed carbon dioxide (CO_2) from the atmosphere, effectively cooling the global climate (Frolking & Roulet 2007) (Box 1). Most of the carbon is then stored below ground as dead organic matter (peat), where in most northern peatlands it has remained for up to 10,000 years (Figure 1) (Yu 2011). Although some carbon is released from the peatland to the atmosphere as methane (CH_4) and CO_2, or as waterborne particulate or dissolved organic carbon, in most undisturbed northern peatlands the amount of carbon added is greater than carbon loss. This makes northern peatlands effective carbon sinks, a process that ensures peatland carbon stores continue to increase. At more northern latitudes, decomposition in permanently frozen (permafrost peatlands) or seasonally frozen peat is further supressed, preserving peatland carbon stores. In permafrost-peatland landscapes, most carbon release to the atmosphere as CH_4 or CO_2 is limited to the warmer summer season.

In contrast, most of the carbon in tropical forests is stored above ground in living plants for a relatively short time, with a smaller portion stored as soil carbon for up to 100-500 years (Figure 1) (Wang et al. 2017a). Similarly, the majority of carbon in boreal forests with well-drained soils is stored above ground in trees and other plants, with soil carbon stored for a relatively short time when compared to the very old carbon stored in peat soils (Deluca & Boisvenue 2012).

Top, American toad (Anaxyrus americanus); bottom, lichens (Cladina stellaris) (Credit: Lorna I. Harris/ WCS Canada)

The importance of the carbon sink function and long-term carbon storage of northern peatlands for global climate regulation is now recognised by scientists (IPCC 2018, IPCC 2019). To prevent dangerous impacts of global climate warming, it is essential that peatlands continue to remove CO_2 from the atmosphere and that the carbon stored in peatlands remains there (IPCC 2018, IPCC 2019).

Peat is not only rich in carbon. More than 80% of peat is water (Joosten & Clarke 2002). Peatlands therefore play an important role in the water cycle, by holding a significant volume of fresh water that supports an extensive network of rivers, lakes and other wetlands (Glooschenko 1990, Riley 2011). This fresh water is critical for biodiversity, fisheries and as a water resource (e.g., clean drinking water) (Glooschenko 1990, Joosten & Clarke 2002). Peatlands may also absorb and filter contaminants, with the very slow flow of water through peat soil helping to maintain downstream water quality (Ritson et al. 2016, McCarter et al. 2017). (See also the Fish and freshwater section).

Peatlands are also home to diverse species of flora and fauna. Peatlands provide vital habitat for a host of different bird species, fish, mammals, amphibians and water-dependent insects (Parish et al. 2008, Minayeva et al. 2017). Many peatland plant species are also important food sources for both people and animals. For example, large areas of peatland across the boreal and sub-Arctic ecozones are covered in lichens, an important winter food source for caribou (Magoun et al. 2005). Cloudberry (*Rubus chamaemorus*), blueberry (*Vaccinium* sp.), cranberry (*Vaccinium* sp.) and crowberry (*Empetrum* sp.) are abundant food sources in northern peatlands (Peatland Ecology Research Group 2009), and the evergreen shrub Labrador tea (*Rhododendron groenlandicum*) is frequently used as a medicine. (Karst 2010).

Labrador tea (Rhododendron groenlandicum) (Credit: Lorna I. Harris/WCS Canada)

Where are peatlands located?

The majority of the world's peatlands (close to 85%) are found in northern latitudes, across the temperate, boreal and sub-Arctic ecozones (Yu et al. 2010, Hugelius et al. 2020). These northern peatlands cover around four million km^2, with just over a quarter (~1.1 million km^2) covering vast areas of Canada (Figure 2)(Yu 2011). Forming a mosaic with extensive coniferous forests, lakes, rivers and other wetlands, peatlands across Canada's boreal and sub-Arctic ecozones are recognized as one of the least impacted ecosystems on Earth (Jones et al. 2018). Huge swathes of mostly uninterrupted peatland cover the northern parts of Québec and Ontario, through Manitoba and Saskatchewan and across to Alberta and the Northwest Territories (Figure 2a). Further north still, many peatlands are permanently frozen (Figure 2b).

Figure 2. Peatlands across Canada: a) non-permafrost peatlands and b) permafrost peatlands in relation to the Fawn River Indigenous Protected Area (IPA) in northern Ontario. Data Source: Hugelius et al. 2020.

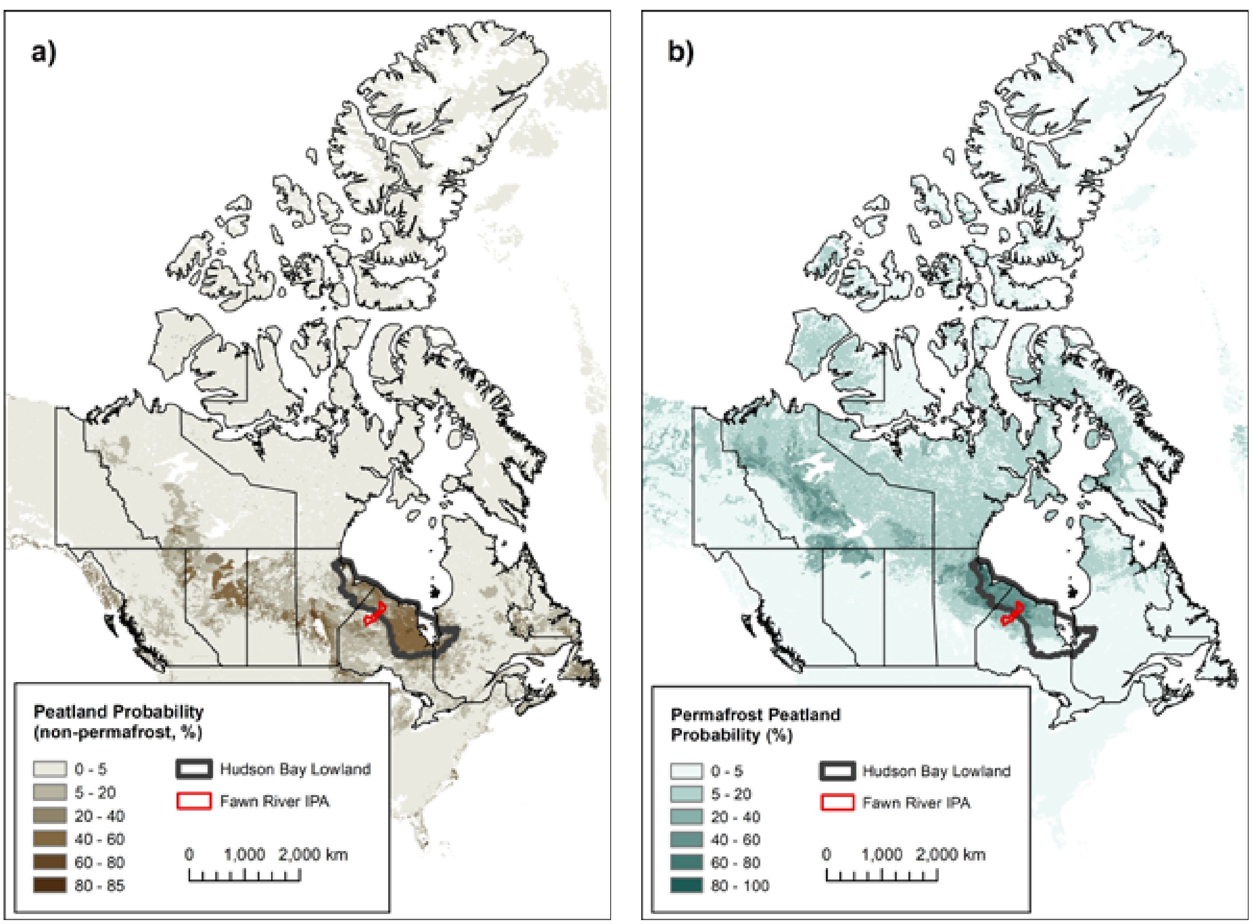
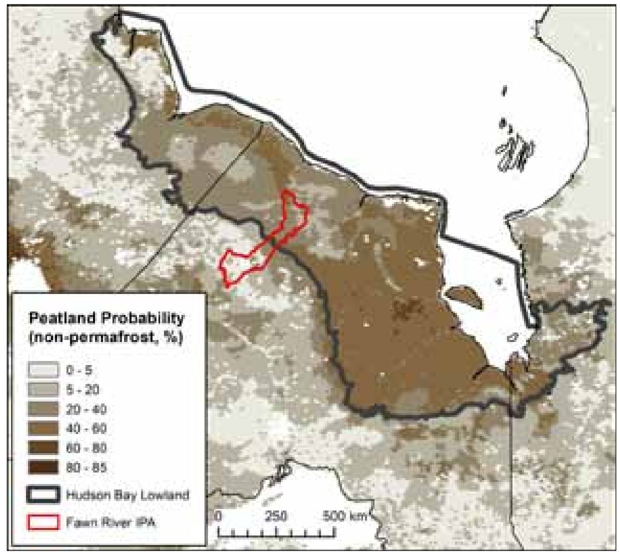


Figure 3. Peatlands (non-permafrost) of the Hudson Bay Lowlands (Hudson Plains Ecozone is shown on the map) and Fawn River Indigenous Protected Area (IPA) in northern Ontario. Data source: Hugelius et al. 2020.

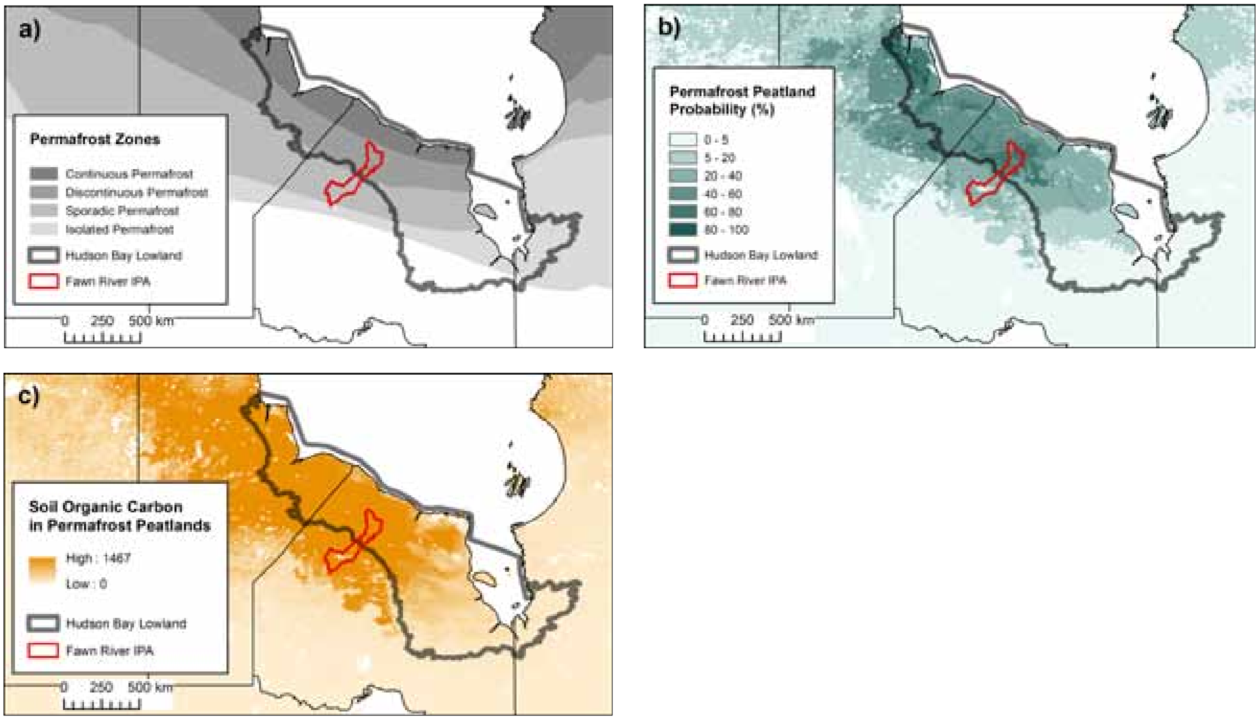


Peatlands of the Hudson Bay Lowlands

The world's second-largest expanse of near-continuous peatlands – the Hudson Bay Lowlands (HBL) – is located in Canada (Figure 2, Figure 3) (Hudson Plains Ecozone; Ecological Land Classification - Statistics Canada 2020). Covering over ~370,000 km^2, the HBL peatlands store around 30-35 billion tonnes of carbon (Riley 2011, Packalen et al. 2014). This immense amount of carbon is more than all of the managed boreal forest in Canada (~28 billion tonnes of carbon) (Kurz et al. 2013).

Peatlands began to form in the HBL around 7,000 years ago following glacial melting and the retreat of the massive inland Tyrrell Sea (Dredge & Cowan 1989). No longer under the weight of the heavy ice sheets, the land slowly began to rise (isostatic rebound), a process that has continued at a rate of 1.2 m every 100 years over the past 1,000 years (Webber et al. 1970). This slow emergence of land from the Tyrrell Sea, the near-continuous cover of impermeable marine clays deposited by this sea, and the flat landscape and cool climate of the region, enabled the expansion of connected wetlands and vast peatlands (Glaser et al. 2004a, Riley 2011, Figure 3). Peatlands in the HBL include bogs and fens with spectacular patterns of pools and parallel ridges (Glaser et al. 2004b, Riley 2011, Harris et al. 2020a).

Figure 4. a) Permafrost zones across the Hudson Bay Lowlands, b) permafrost peatlands and c) carbon stored within permafrost peatlands across the HBL and Fawn River Indigenous Protected Area (IPA) in northern Ontario. Data source: Hugelius et al. 2020.

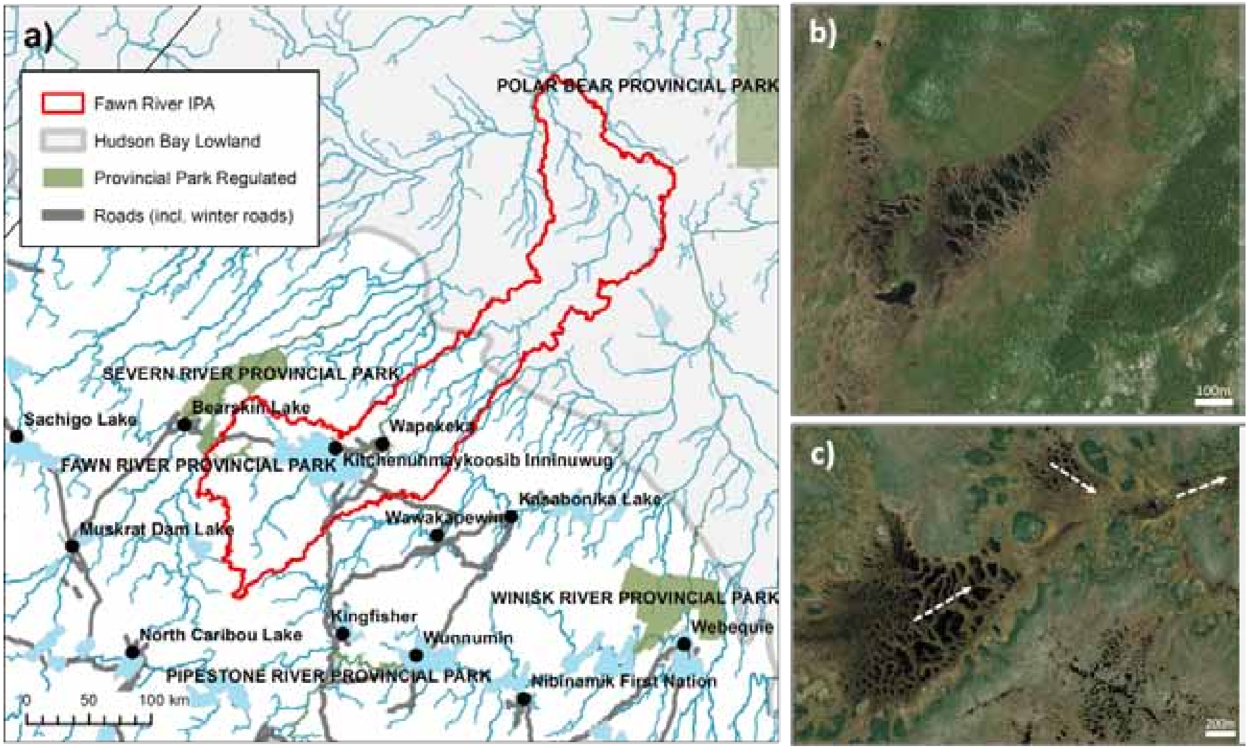


In northern regions of the HBL where there is sporadic to near continuous permafrost (Figure 4a), permafrost peatlands dominate the landscape (Figure 4b) and include frozen raised peatlands (peat plateaus) and smaller permafrost-peatland mounds (palsa) (Riley 2011). Permafrost peatlands in the HBL also store a considerable amount of the total peat carbon for the region (Figure 4c) (Hugelius et al. 2020).

Peatlands across the HBL are in the homelands of many Indigenous communities, including Fort Severn Kitchenuhmaykoosib Inninuwug (KI), Weenusk First Nation, and Attawapiskat First Nation among others. Peatlands form part of this important cultural landscape and are important components of food sovereignty for Indigenous Peoples across the region (Council of Canadian Academies 2014).

The HBL peatlands support many nationally and globally rare plants and lichens and species of national conservation concern (Riley 2003). The HBL is home to Arctic fox (*Vulpes lagopus*) and Arctic hare (*Lepus arcticus*) and provides habitat for many migratory birds including snow geese (*Anser caerulescens*). (See also the Birds section.) Some species found in the HBL are also designated under the *Species at Risk Act* (SARA) (Government of Canada 2020a), including polar bear (*Ursus maritimus*) and wolverine (*Gulo gulo*). For example, the HBL peatlands provide extensive habitat for both the sedentary and migratory ecotypes of woodland caribou (*Rangifer tarandus caribou*) in Ontario, particularly drier lichen-covered peatlands (non-permafrost) and more northern areas with permafrost-peat plateaus (Magoun et al. 2005, Berglund et al. 2014). (See also the Mammals section.) (More information on the fish, birds

Figure 5. a) Location of the proposed Fawn River Indigenous Protected Area with the northern half located within the Hudson Bay Lowlands, b) satellite image of a patterned fen and water track draining from adjacent lichen-covered raised bogs within the Fawn River IPA and c) satellite image of another patterned fen and water track within the Fawn River IPA, with arrows indicating the general flow direction of water from the peatlands to small tributaries of the larger river network within the Severn River watershed. Data source: Zoom Earth Imagery.



and mammals found across the HBL, Boreal Shield, and Fawn River IPA can be found in respective sections of this Ecological Atlas.)

The HBL peatlands also support an extensive network of rivers, lakes and other wetlands that drain towards Hudson Bay and James Bay (Riley 2011, Orlova & Branfireun 2014). Some of the last undammed rivers in North America are in this region and are critical for sustaining huge marshes on the coast of James Bay that are of hemispheric importance for biodiversity.

2. Peatlands of the Fawn River IPA

Just over half of the proposed Fawn River Indigenous Protected Area sits outside the Hudson Bay Lowlands on the Precambrian Shield (Ontario Shield Ecozone), but the landscape comprises a similar and mostly intact mosaic of peatlands and other wetlands, lakes, rivers and forest (Figure 5, Figure 6). Similar to other parts of the HBL, numerous lichen-covered raised bogs are surrounded by patterned fens and water tracks that drain from the bogs to the larger river network within the Severn River watershed (Figure 5b, 5c). In the most southern part of the Fawn River IPA, large patterned fens are situated in a mosaic of greater forest cover than the north.

The Fawn River IPA extends across the zones of sporadic to discontinuous permafrost, with large parts of the IPA covered in permafrost peatlands (Figure 4a, 4b, Figure 6). In the northern part of the Fawn River IPA, permafrost peatlands that are permanently frozen with only about the upper 40 cm thawing

Figure 6. a) Satellite image of the Fawn River Indigenous Protected Area (IPA) with the northern half located within the Hudson Bay Lowlands, b) non-permafrost peatlands and c) permafrost peatlands within the Fawn River IPA. Data sources: ESRI Basemaps, Hugelius et al. 2020.

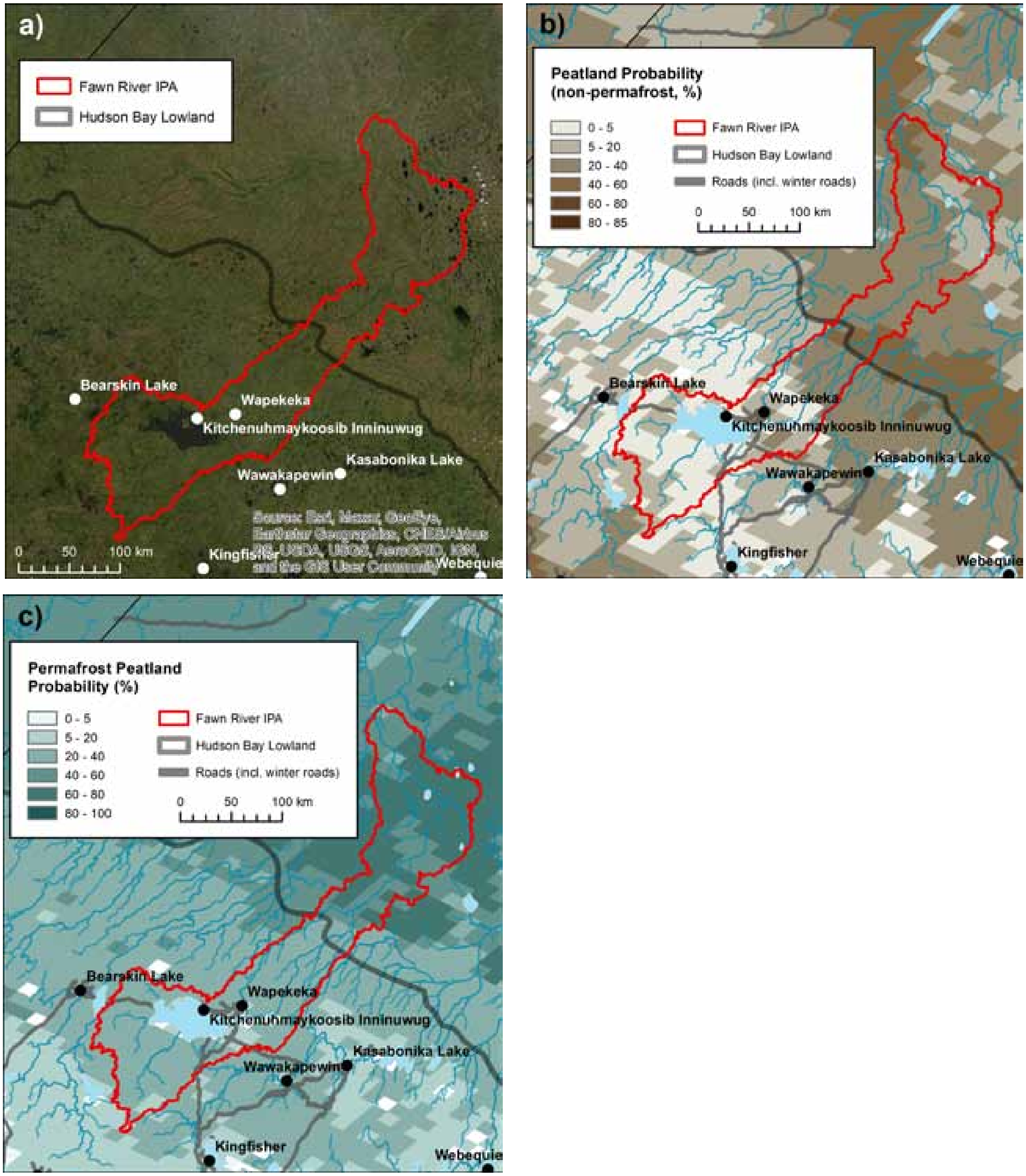
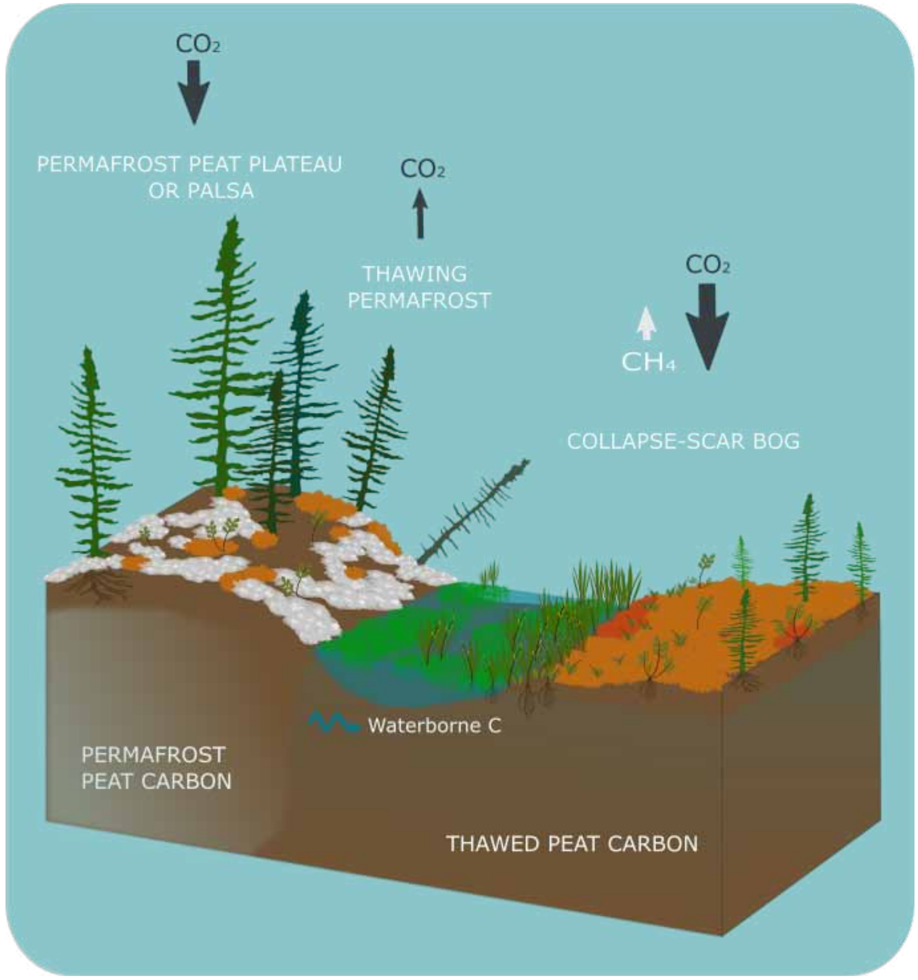


Figure 7. Simplified diagram of land cover change following thaw in permafrost peatlands.

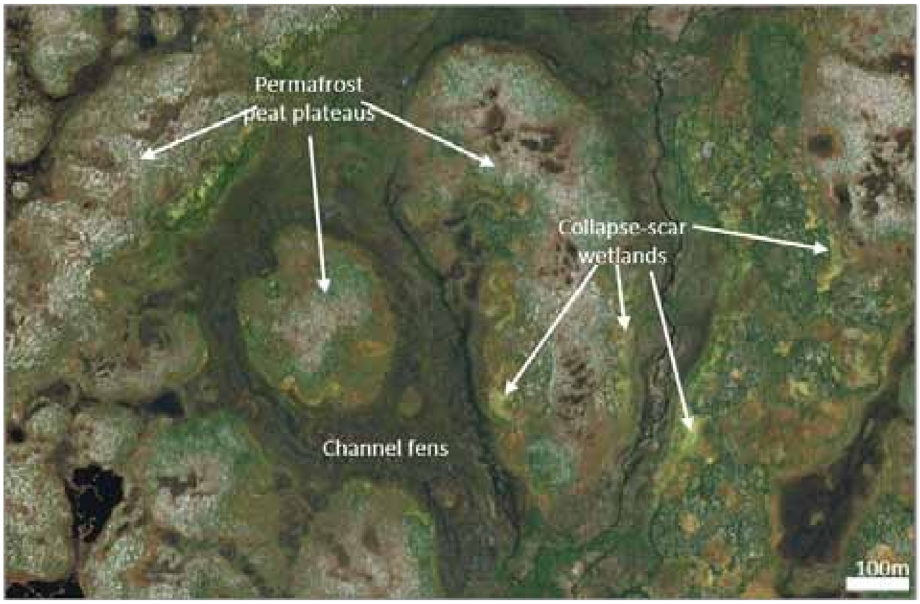


in the warmer summer months before freezing again in winter. The surface of these raised permafrost-peat plateaus is dry and typically covered in lichens and some black spruce trees. The surrounding wetlands, which may include fen water tracks (channel fens), are usually dominated by sedges. Where permafrost has thawed at the edge of the peat plateau and caused it to collapse, a new collapse-scar wetland may form with new growth of *Sphagnum* moss and sedges replacing lichens and black spruce trees (Figure 7, Figure 8).

3. Benefits to people provided by the Fawn River IPA peatlands ecosystem

Peatlands provide numerous valuable ecosystem services, including regulating, supporting and provisioning services, such as carbon storage for global climate regulation, wildlife habitat and storage of fresh water. The HBL peatlands and those within the Fawn River IPA are no exception, with the mostly intact landscape representing a hotspot within Canada for multiple ecosystem services (Mitchell et al. 2020).

Figure 8. Lichen-covered permafrost peat plateaus surrounded by water tracks (or channel fens) in the northern part of the Fawn River IPA. Bright green patches represent new growth of *Sphagnum* moss in recently formed collapse-scar wetlands (or thermokarst bogs) where permafrost has thawed. Orange-brown areas represent areas that thawed a few hundred years ago or more, and where peat has slowly built up again following thaw. Data source: Zoom Earth Imagery.



Regulating services are ecosystem processes that maintain air quality, water quality and quantity and soil conditions. Peatlands provide critical regulating services for global climate and water, but these services have often been overlooked and undervalued in decision making about land use and development. As they are mostly intact and undisturbed, peatlands within the Fawn River IPA are currently very likely to be functioning at the optimal level for climate (e.g., removing CO_2 from the atmosphere and storing the carbon in peat soils) and water quality and quantity regulation (e.g., storing fresh water that is slowly released to the downstream river network within the Severn River watershed), as supported by studies of similar undisturbed peatlands in other parts of the HBL (e.g., Humphreys et al. 2014), model projections (Qiu et al. 2020) and regional assessments (e.g., WWF 2020). Due to the size of the peatlands and their carbon storage within the Fawn River IPA, their contribution to global climate regulation is very important, particularly as these peatlands remain mostly undisturbed.

Blueberry (Vaccinium myrtilloides) (Credit: Lorna I. Harris/WCS Canada)

Supporting services are the living spaces for plants and animals and the ecosystem processes that sustain the ecosystem (e.g., soil formation, nutrient storage and cycling). The process of forming peat soils, and the unique habitat for plants and wildlife that this process creates, are supporting services provided by peatlands. Intact and undisturbed peatlands within the Fawn River IPA provide optimal habitat for a range of plant and animal species. The ecological significance of the habitat within the Fawn River IPA, particularly as climate change refugia (Stralberg et al. 2020), is further enhanced by the uninterrupted connection to peatlands, lakes and rivers within the larger HBL landscape.

Provisioning services are the material benefits provided by an ecosystem that may be extracted for human use. For example, peatlands provide fresh water sources of drinking water, support fisheries and provide plants that may be used as food and medicine. In their current mostly undisturbed state, peatlands within the Fawn River IPA continue to store fresh water and may also provide medicines and food such as berries for local communities (Karst 2010).

Conserving the full range of ecosystem services provided by peatlands within the Fawn River IPA is possible with careful land-use planning that takes into consideration the broader context and the interconnected nature of the region in which the Fawn River IPA is embedded. Each ecosystem service provided by peatlands within the IPA area depends on maintaining the overall function of the peatlands – in both headwater areas and downstream – so that all ecosystem processes may operate within their optimal range. Healthy peatlands are also more resilient to environmental change (e.g., climate change), continuing to provide the full range of ecosystem services even when under slight stress (e.g., due to long-term variable weather patterns)(Belyea & Baird 2006).

Arctic raspberry (Rubus arcticus) (Credit: Lorna I. Harris/WCS Canada)

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4. Threats

Climate change

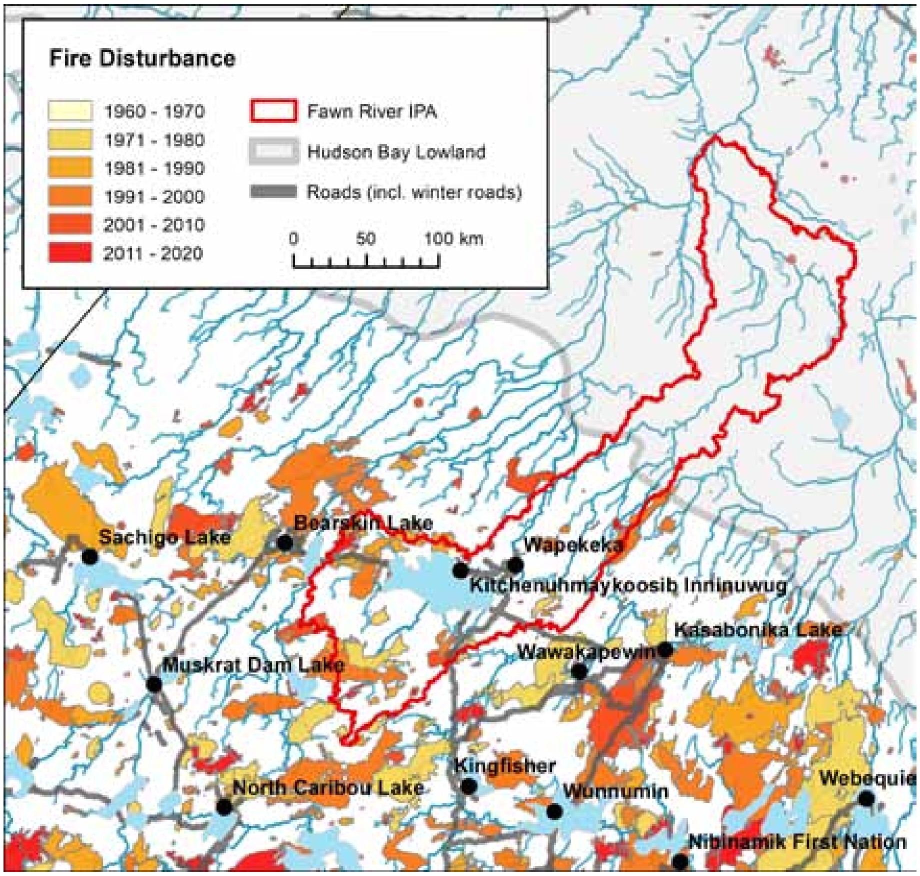
If left undisturbed, non-permafrost peatlands in the Hudson Bay Lowlandss, including the Fawn River Indigenous Protected Area, are likely to continue effectively removing CO_2 from the atmosphere and storing this carbon in all but the worst climate-warming scenarios (McLaughlin & Webster 2014, McLaughlin et al. 2018, Qiu et al. 2020). However, permafrost peatlands in the region may experience more rapid thaw, potentially releasing large amounts of carbon to the atmosphere (McLaughlin & Webster 2014, Hugelius et al. 2020). Mean annual temperatures in the HBL are projected to increase by 2.5 and 8°C (McKenney et al. 2010), with potentially significant consequences for permafrost peatlands and their stored carbon, both in the HBL and the proposed Fawn River IPA. Changes in land cover due to permafrost thaw (Figure 7, Figure 8) may also alter drainage pathways, which could negatively affect downstream water quantity and quality (e.g., Quinton et al. 2011).

Wildfire

While the risk of wildfire in the wet landscape of the HBL and northern part of the Fawn River IPA is low (fire return interval ~600-1,000 years), prolonged dry periods associated with future climate warming may increase this risk, particularly for drier permafrost plateaus and non-permafrost bogs with greater black spruce cover (Balshi et al. 2009, Riley 2011, McLaughlin & Webster 2014, Wang et al. 2017b). The risk of wildfire in the southern part of the proposed Fawn River IPA, located on the Precambrian Shield (Ontario Shield Ecozone), is greater than the HBL although still smaller than forests further south (Crins et al. 2009, Coops et al. 2018). The fire return interval for the Ontario Shield in the west is estimated at ~140 years (Coops et al. 2018).

In both the HBL and Ontario Shield portions of the Fawn River IPA, drier peatlands are generally at greater risk of ignition and are more vulnerable to

Figure 9. Areas within and surrounding the Fawn River Indigenous Protected Area that have been impacted by fire. Data source: Land Information Ontario 2020.



prolonged peat smouldering, with potentially large losses of carbon (Turetsky et al. 2011). Changes in surface vegetation following wildfire, including the loss of trees and shrubs, also impacts wildlife habitat and available food sources (lichens and berries) in peatlands (e.g., Dalerum et al. 2007, Wieder et al. 2009). Downstream water quality may also be negatively impacted by wildfires in peatlands, with short-term and potentially long-term post-fire increases in sediments, nutrients and waterborne carbon (e.g., Emmerton et al. 2020).

Maps of fire disturbance show large areas to the south of the Fawn River IPA (within the Ontario Shield Ecozone) have been burned, from the 1960s through to present, but more northern regions (within the HBL) remain mostly unaffected by fire (Figure 9). Fire disturbance areas within the Fawn River IPA itself are also constrained to the southern region and are smaller than most burned areas outside the IPA, with only a few small areas within the IPA that have burned in the past 20 years.

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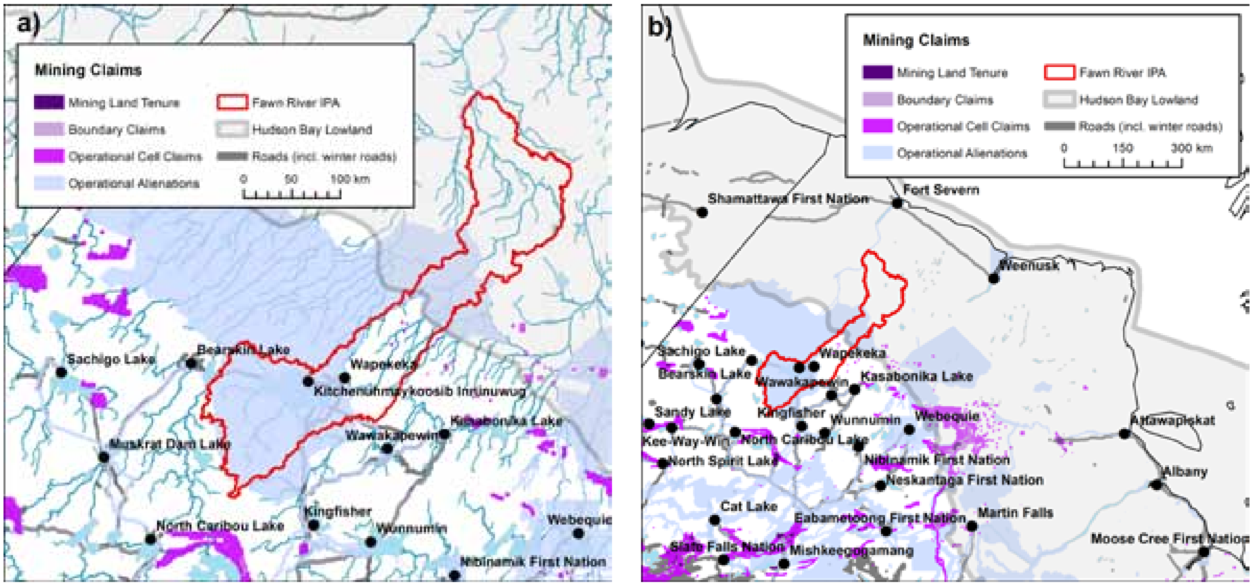
Current and future land use

Peatlands within the proposed Fawn River IPA remain mostly intact, with relatively limited industrial development and human footprint (e.g., roads, settlements) located entirely in the southern portion of the IPA (Figure 5a). However, peatlands within and surrounding the Fawn River IPA are at significant risk of

Figure 10. a) Operational mining claims within and surrounding the Fawn River IPA (current as of December 2020) and b) location of the Ring of Fire mineral deposit near Webequie. Data source: Mining Lands Administration System - Ontario Ministry of Energy, Northern Development and Mines 2020.



disturbance from mineral exploration activities and by future mining developments and associated infrastructure (Figure 10a). A major mining development for world-class mineral deposits (e.g., chromite), termed the Ring of Fire, has been proposed for an area of the HBL (Chong 2014), around 60 km east of Webequie First Nation (Figure 10b). The large area of mineral claims has been expected to undergo a Regional Assessment (Government of Canada 2020b), along with ongoing road projects being assessed by Canada and Ontario as proposed access roads to the mineral deposits as well as communities (Government of Canada 2020c). Although the proposed development is not within the Fawn River IPA, the creation of access roads (all-season and winter) and other significant infrastructure in the region places the peatlands of the Fawn River IPA and interconnected rivers and lakes at significant risk of future development.

For open-pit mining, the entire surface peat is removed to reach underlying rock and mineral deposits, resulting in the complete loss of the peatland and its value as a carbon store, wildlife habitat and as a food source. Access roads for mining developments may cut through or be laid on top of the peatland (as floating roads or on top of permafrost), but in both situations the construction of the road changes the flow of water within the peatland, resulting in either flooding or drying on one side of the road (Plach et al. 2017, Williams-Mounsey et al. 2021).

These changes to peatland vegetation and water storage and flow caused by land-use change and infrastructure development, significantly affect the carbon stored within the peat soils. Drier surface conditions and lower water tables expose previously saturated peat to increased aerobic decomposition and carbon release to the atmosphere as CO_2, while also reducing plant productivity and the amount of carbon removed from the atmosphere (Harris et al. 2020b). If the peatland surface is flooded above normal levels, more carbon may be released as methane (CH_4)(Saraswati & Strack 2019). In permafrost peatlands, roads placed on the surface of the permafrost and including vegetation clearance for winter roads or other infrastructure, increase the potential for more rapid permafrost thaw (Williams et al. 2013). As permafrost thaws, carbon release to the atmosphere occurs as CO_2 and methane and there may also be increased loss of waterborne carbon in a recently thawed, wetter landscape (Figure 7).

Studies of peatlands in other parts of the HBL highlight the importance of the hydrological connection within and between peatlands and the wider landscape for peatland development (e.g., Glaser et al. 2004b, Harris et al. 2020a), which, in turn, influences downstream water quantity and quality. The removal of peatlands for open-pit mining reduces the storage capacity for clean fresh water within the watershed, with changes to flow quantity and/or water quality downstream. Increased waterborne carbon, nutrients and contaminants in streams and rivers draining disturbed peatlands are likely (Gibson et al. 2009), with potentially negative impacts on fisheries and human health (Lescord et al. 2020).

A road for a mining development cutting through a peatland in the HBL. (Credit: Lorna I. Harris/WCS Canada)

Peatlands are also natural sources of bioaccumulating and highly toxic methylmercury to surface waters (Branfireun & Roulet 2002, Mitchell et al. 2008). However, production and release of methylmercury to connected watercourses may be increased in peatlands that are disturbed for mining and infrastructure development (Braaten & de Wit 2016, Wasiuta et al. 2019), with possibly severe consequences for downstream fisheries and human health (UNEP 2013, Lescord et al. 2019). For example, methylmercury production may increase in peatlands that are flooded as a result of road development or other infrastructure (St. Louis et al. 2004). Mining activities may also increase mercury deposition in surrounding peatlands, which may increase the source potential for methylmercury production (Kirk et al. 2014).

Invasive species

Similar to the larger HBL region, most peatlands within the Fawn River IPA are likely unaffected by invasive species, either introduced through human land use such as roads, or moving north due to a northwards shift in environments due to climate change (Far North Science Advisory Panel 2010). However, land cover change in peatlands, particularly for economic development and associated infrastructure, provides the ideal conditions for opportunistic and potentially invasive plant and animal species to establish (Dub et al. 2011, Kent et al. 2018). For example, in disturbed peatlands, fast-growing non-peatland plants or other wetland plants (e.g., bulrush – *Typha latifolia*) may establish and dominate on an open soil surface or in changed hydrological conditions (Bourgeois et al. 2012). Changes in vegetation cover in peatlands may then impact available food sources and habitat for wildlife. Invasive plant species may be introduced as seed or plant fragments on vehicles or equipment and spread from the infrastructure footprint to adjacent peatland areas and beyond (Jodoin et al. 2007, Dub et al. 2011).

Contaminants and pollution

The risk of contaminants and pollution from existing infrastructure impacting peatlands within the Fawn River IPA is likely to be low, particularly as few settlements and roads are located in the southern part of the proposed IPA (Figure 5a). Risks associated with existing infrastructure include oil spills from vehicles, vehicles and/or equipment falling into adjacent peatlands and potential changes to air quality (e.g., dust from roads, vehicle emissions). However, if mining and infrastructure development close to and within the Fawn River IPA were to increase, the risk of contaminants and other pollution impacting peatlands may be significant, as vehicle numbers increase and with more frequent transport of heavy equipment. For example, increased deposition of mercury due to mining activity is possible, which would increase the potential for methylmercury production in peatlands and release to downstream rivers and lakes (Kirk et al. 2014).

Top: A mining access road made from local limestone cutting through a peatland in the HBL. Bottom: A drained peatland near a mine in the HBL. The dry conditions have reduced the cover of Sphagnum *moss on the surface of raised hummocks and former peatland pools now have a bare peat surface. (Credit: Lorna I. Harris/WCS Canada)*

Dust and heavy metals from vehicles on all-season roads and mining operations can also travel and settle on vegetation and in waterbodies far from the point source, with the dust plumes and disturbances also impacting wildlife and First Nations communities (Santelmann & Gorham 1988, Myers-Smith et al. 2006). The ecotoxicological effects of the materials (e.g., plastic tracks and sheeting) used to build roads on or through peatlands are also unknown (Williams-Mounsey et al. 2021). It is also possible that mining developments may propose to use peatlands to polish treated wastewater (McCarter et al. 2017), although the long-term effects on peatland vegetation and processes that control carbon cycling remain uncertain (e.g., Lavallee 2017).

Interactive and cumulative effects

Most undisturbed peatlands are resilient to environmental change (Belyea & Baird 2006). When disturbed, however, peatland vegetation and hydrology (flooding or drainage) may be significantly changed, and the ability of peatlands to remove CO_2 from the atmosphere and to accumulate carbon in peat soils is reduced or lost (Harris et al. 2020b). Peatlands that are affected by one stressor are also more vulnerable to other stressors, with the combined effects causing more rapid or increased carbon loss. For example, changes to peatland vegetation and hydrology due to global climate warming may increase the risk from other stressors, including wildfire and invasive species. Peatlands that are drained for mining and infrastructure development are at greater risk of fire ignition, severe wildfire and prolonged peat smouldering (Turetsky et al. 2011, Granath et al. 2016).

Loss of peatland vegetation due to wildfire can, in turn, lead to a greater risk of invasive species introduced via roads and other infrastructure. Downstream changes to river water quality (e.g., increased nutrients and metals) in areas with burned peatlands are also likely, with consequences for wildlife and fisheries (Emmerton et al. 2020).

All peatlands within the Fawn River IPA will be affected to a certain extent by climate warming, but the effects are likely to be limited if the peatlands remain intact and undisturbed (Qiu et al. 2020). Permafrost peatlands in the Fawn River IPA are at high risk of thaw and subsequent land cover change due to climate warming, but additional disturbance through infrastructure development (e.g., roads and other linear disturbances) is likely to accelerate this process (Williams et al. 2013). Wildfire is also likely to cause more rapid thaw (Gibson et al. 2018). Permafrost thaw may also increase the availability of mercury stored in permafrost peatlands for the production of methylmercury, which is more likely to reach downstream rivers and lakes in a wetter and more hydrologically connected landscape (Gordon et al. 2016).

5. Recommendations

Protection

Peatlands within and surrounding the proposed Fawn River IPA are of global importance for climate regulation. If Canada is to meet global targets for net-zero carbon emissions by 2050 as set out in the Paris Climate Agreement (Government of Canada 2016), from a scientific perspective it is critical that these peatlands continue to remove CO_2 from the atmosphere and that their long-term carbon storage remains undisturbed.

Cloudberry (Rubus chamaemorus) (Credit: Lorna I. Harris/WCS Canada)

Peatlands within this region have been identified as a hotspot within Canada for many other essential ecosystem services, including freshwater storage and supply to an extensive downstream river network, wildlife habitat and cultural services. Protecting peatlands within a wider landscape setting of mostly intact boreal forest will ensure they continue to provide multiple benefits for current and future generations of First Nations, Ontarians and Canadians.

Policies that recognize Kitchenuhmaykoosib Inninuwug's jurisdiction and approach to protection should also confer provincial and federal protections together with policies and regulations about avoided conversion of peatlands, both within the Fawn River IPA and the broader regional context in which the IPA is embedded. These policies should be co-created with KI and other First Nations.

Research and monitoring

Scientific studies of peatlands within the HBL are limited and even more so for the proposed IPA. The lack of publicly available scientific data for the Fawn River IPA means the scientific status of the peatlands, and potential impacts of current and future disturbances, are uncertain. Studies of peatlands within the larger HBL landscape (e.g., Humphreys et al. 2011, McCarter et al. 2017, Harris et al. 2020a, Harris et al. 2020b) are likely to be relevant to peatlands within the Fawn River IPA, but further research and monitoring of peatlands within the IPA is needed to understand the range of ecosystem services and their interactions.

Top, Peatlands in the Attawapiskat River area of the HBL. Bottom, A raised wooden boardwalk used for peatland research and monitoring. (Credit: Lorna I. Harris/WCS Canada)

Studies of permafrost peatlands within the proposed IPA, to determine potential for permafrost thaw and future land cover change, would be particularly useful as thaw will not only impact carbon storage, but also drainage networks and the quantity and quality of water reaching downstream ecosystems. If development of infrastructure for mining, forestry or other works are proposed within the IPA, or in the areas surrounding the IPA (i.e., areas with a hydrological connection to peatlands and rivers in the IPA), then further research and data collection for baseline conditions (including detailed mapping of different peatland types), surveys and analysis of peat-carbon cycling, surveys of peatland connection to the wider river network, and extensive monitoring (including long-term data collection), will be required to avoid and reduce impacts to the peatlands to ensure they continue to provide critical ecosystem services.

Research and monitoring projects begin with the free, prior and informed consent of Kitchenuhmaykoosib Inninuwug and other First Nations and should be co-created. Projects should consider First Nations values and interests through equitable community-based research and monitoring to understand the current condition and changes across the peatlands within the Fawn River IPA (Johnson et al. 2015, McKay & Johnson 2017).

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Wildlife Conservation Society Canada
344 Bloor Street West, Suite 204
Toronto, Ontario. M5S 3A7   CANADA
Telephone: (416) 850-9038

WCS CANADA

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