

Bending the curve of biodiversity loss: Identifying barriers and opportunities to
accelerate endangered species recovery in Canada

by

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A thesis

presented to the University of Waterloo

in fulfillment of the

thesis requirement for the degree of

Doctor of Philosophy

in

Social and Ecological Sustainability

Waterloo, Ontario, Canada, 2025

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AUTHOR'S DECLARATION

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

STATEMENT OF CONTRIBUTIONS

This thesis contains six chapters that are collaborative efforts that have been published or in preparation for submission to peer-reviewed journals. Daniel Kraus is first author on all contributing papers and therefore was responsible for the development, data collection, data analysis and preparation of each of the manuscripts found in this dissertation. The written portions of all chapters, including figures and tables, were completed in their entirety by Daniel Kraus and edited for content and composition by thesis supervisor Dr. Stephen Murphy, the committee members, and additional co-authors. Chapter 3 (co-authors: A. Enns, A. Hebb, S. Murphy, D.A.R. Drake & B. Bennett) and chapter 4 (co-authors: S. Murphy & D. Armitage) of this thesis have been published in *Conservation Science and Practice* and *Facets*, respectively. Manuscripts are in the process of being developed for chapters 2 and 5. Authorship and acknowledgements are provided at the beginning of each chapter. During preparation of this work, the author used ChatGPT in some sections to improve readability. Any text generated by AI was reviewed and edited to ensure accuracy and consistency.

ABSTRACT

The decline of wild species represents one of the most urgent crises of our time, with significant ecological, cultural, and economic implications. Understanding the barriers and opportunities to accelerate wildlife recovery is essential to inform effective conservation planning, policymaking, and action, and ultimately to halt and reverse the loss of nature. Research for this thesis was guided by three interconnected objectives: 1) identify the patterns and processes of wildlife extinction and recovery in Canada, with a detailed examination of nationally endemic species, 2) compare and examine the effectiveness of national approaches to endangered species assessment, listing and recovery, thereby identifying bridges and barriers to recovery, and 3) develop and advance new approaches to planning and implementation that will accelerate endangered species recovery in Canada. These objectives are intended to provide novel contributions that fill key knowledge gaps to support the practice of endangered species conservation.

This research describes over 200 species ‘missing’ from Canada since European settlement, revealing significantly more extinctions and extirpations than reported under the *Species at Risk Act*. These losses are concentrated in Ontario, BC, and Quebec, with unsustainable harvesting historically driving extinctions, and habitat degradation emerging as the dominant contemporary threat. In contrast, the research also identifies 49 species with genuine improvements in conservation status, as well as over 50 species that began to recover before formal national assessments began. Key drivers of recovery include harvest management, pollution abatement, with more contemporary recoveries resulting from translocations, stewardship, and protected areas. The research also highlights that most improvements in the conservation status of species at risk are the result of discovering new populations and cautions against misclassifying these as conservation successes.

This research also provides the first comprehensive inventory of Canada’s 308 nationally endemic species, approximately 90% of which are of global conservation concern. The analysis identifies 27 spatial concentrations of endemic species, many of which are associated with glacial refugia, islands, coasts, and unique habitats. Despite their significance, nationally endemic species have not been prioritized in national conservation efforts, but their conservation will play an essential role in Canada’s contribution to preventing global extinctions.

Drawing on comparisons with the US and Australia, the thesis identifies systemic barriers to endangered species recovery and offers ten strategic "bridges" to overcome them. These include ecosystem-based recovery, community co-governance, linking wildlife recovery to ecosystem services, and improving public narratives around wildlife loss and recovery. Insights from a survey of 136 Canadian recovery planning practitioners further highlighted that effective implementation of SARA remains illusive, with respondents emphasizing the need for improved consultations, co-production with Indigenous communities, streamlined processes, and knowledge sharing.

The thesis concludes by proposing pathways to reduce extinction risks and accelerate recoveries that are based on the relationships between processes, places and peoples. These include approaches to increase proactive conservation, supporting community-based recovery planning and action, and improving knowledge mobilization. These recommendations aim to strengthen Canada’s capacity to meet its national and global biodiversity commitments and bending the curve of biodiversity loss.

ACKNOWLEDGEMENTS

My deepest gratitude to Dr. Stephen Murphy for his encouragement and support throughout this PhD journey, especially during the challenges of the pandemic. I am also profoundly grateful to the other members of my Steering Committee for their invaluable advice, knowledge, and support: Dr. Derek Armitage, Dr. Jeremy Pittman and Dr. Andrew Drake. I will always be thankful for your guidance and look forward to continuing to learn from all of you. Special thank you to Dan McCarthy, Trevor Swerdfager, Tim Alamenciak, Scott Parker, and Simon Courtenay for their advice and input.

This thesis would not have been possible without the support of my employers. I extend my heartfelt thanks to Jane Gilbert, John Lounds, and Natalie Zinger at Nature Conservancy of Canada (NCC) for their support and flexibility which allowed me to embark on this research and the encouragement of my friends at NCC. I also appreciate the support from Dr. Justina Ray and colleagues at the Wildlife Conservation Society Canada.

My research greatly benefitted from the time and talents of many people. Thank you to my co-authors of the published chapters: Amie Enns (NatureServe Canada), Andrea Hebb (Nature Conservancy of Canada), and Bruce Bennett (Yukon Conservation Data Centre). My conversations with Christie Whelan and Tanya Pulfer at Environment Canada Climate Change and Dr. Nick Mandrak (University of Toronto) provided a much-needed sounding board. I am also indebted to the numerous experts who took the time to complete the survey on species at risk recovery planning and provided input on Canada's 'missing' and endemic species.

This thesis was a family affair. My wife and life partner, Ann, kept me grounded; her love and encouragement are behind every keystroke. For her patience and understanding in supporting me and our two sons in pursuing university degrees, I will be forever grateful. Skylar and Logan, thank you for your encouragement. I hope, in some small way, this research helps make the world a better place for you.

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STATEMENT OF POSITIONALITY

Chapter 1 of my thesis includes a summary and review of the history of wildlife conservation in Canada. Before presenting this information, I want to acknowledge that the history I will present to you is through my lens – that of a privileged white settler of German, Irish, and Danish descent. I grew up in a rural small-town and believed stereotypes about Indigenous Peoples that I now know are false. I thought it was important to include both my positionality statement and Indigenous Acknowledgment to provide context to the chapter on conservation history you are about to read.

The history of conservation in Canada is tainted with racism and injustice. These span from residential schools that deliberately attempted to suppress the relationship of Indigenous Peoples with nature to the expulsion of the Stoney Cree in the creation of Canada's first national park. Many of the events and publications that I refer to in Chapter 1 are deeply rooted in colonialism and colonial racism.

My accounting of wildlife conservation history is focused on Western perspectives, but there are two important truths around Indigenous Peoples and conservation I have learned through my research and want to share with you.

The first is that many of the early European descriptions of Indigenous Peoples and the environment where they lived were both highly biased and reflected Peoples that had been devastated by diseases introduced through the first European contact (Denevan 1992).

The second truth I want you to know that Indigenous Peoples have been stewards of wildlife since time began (Ellis et al. 2021; Ellis et al. 2010). They managed wildlife populations, created agricultural systems that worked with natural systems (Deur et al. 2015), and used fire to manage plants, animals, and ecosystems (Miller et al. 2010). Their stewardship of land, water, and wildlife often increased the diversity of ecological systems.

As you will read in Chapters 4, 5, and 6, there is an increasing recognition in Western-based conservation that listening and learning about Indigenous perspectives through a 'two-eyed seeing' approach (No'kmaq et al. 2021) are not just helpful, but necessary for effective action to halt and reverse the loss of wildlife.

Finally, I want to acknowledge the campuses of the University of Waterloo are situated on the Haldimand Tract, land that was granted to the Haudenosaunee of the Six Nations of the Grand River, and are within the territory of the Neutral, Anishinaabe, and Haudenosaunee peoples.

CHAPTER 1. INTRODUCTION: THE BIODIVERSITY CRISIS & CONSERVATION IN CANADA

Chapter 1 has been researched and written by Daniel Kraus. The intent is to provide an overview of biodiversity and endangered species conservation in Canada through a broader socioecological lens. Several of these sections, including Indigenous-led conservation and assessing extinction risk, also provide important context to later chapters in my thesis.

This chapter includes references to three papers that I coauthored during my Ph.D. studies. While not the focus of my research they contributed to the broader contextual understanding shared in this chapter.

- Westwood, A.R, Otto, S.P., Mooers, A., Darimont, C, Hodges, C.E., Johnson, C., Starzowski, B.M., Burton, C., Chan, K.M.A., Festa-Bianchet, M., Fluker, S., Gulati, S., Jacob, A.L., **Kraus, D.**, Martin, T.G., Palen, W.J., Reynolds, J.D., Whitton, J. 2019. Protecting biodiversity in British Columbia: Recommendations for developing species at risk legislation. *FACETS*. 4(1): 136-160. <https://doi.org/10.1139/facets-2018-0042>
- **Kraus, D.**, & Hebb, A. 2020. Southern Canada's crisis ecoregions: Identifying the most significant and threatened places for biodiversity conservation. *Biodiversity and Conservation*, 29, 3573–3590. <https://doi.org/10.1007/s10531-020-02038-x>
- Grace, M. K., Akçakaya, H. R., Bennett, E. L., Brooks, T. M., Heath, A., Hedges, S., . . . **Kraus, D.**, Young, S. 2021. Testing a global standard for quantifying species recovery and assessing conservation impact. *Conservation Biology*, 36(6), 1833-1849¹. <https://doi.org/10.1111/cobi.13756>

¹ This paper is coauthored by 200 contributors that also tested the IUCN Green List standard. I tested the draft standard using two species at risk from Canada: Lake Erie Watersnake (*Nerodia sipedon insularum*) and Dwarf Lake Iris (*Iris lacustris*) in preparation of the manuscript.

1.1 EXTINCTION AND THE BIODIVERSITY CRISIS

Extinction is an integral part of life on Earth. Understanding past extinction rates and drivers provides a baseline by which to better understand our current, accelerated rate of extinction that is interwoven in the biodiversity crisis. Extinction co-occurs with speciation. It is a natural and important evolutionary process (Barnosky et al. 2011; Raup 1994) and all species have traits making them vulnerable or resilient to extinction. These include population size, range, reproductive rate, motility, and number and distribution of subpopulations (Mace et al. 2008; Purvis et al. 2000). Background extinction rates are estimated at approximately 0.1 to 1 species extinctions per one million species per year (Ceballos et al. 2015; De Vos et al. 2015). While background extinction normally occurs slowly and locally, species can also be vulnerable to stochastic extinction events (Shaffer 1981). These events are typically localized, such as volcanic activity on an island that wipes out endemic species, but stochastic events can also occur on a planetary scale. These large scale events have resulted in five mass extinction events in the Earth's history (**Table 1**) (based on Sepkoski 2002). We are currently witnessing what some have termed the "sixth extinction" (Ceballos et al. 2015; Ceballos et al. 2017; Kolbert 2014; Pimm & Brooks 2000). While past extinction events were caused by rapid geological change and asteroids, current accelerated rates of extinction are driven by human activities.

Table 1: Earth's five mass extinctions events

Name/ timing/ duration	Primary extinctions	Causes
1. Ordovician-Silurian Extinction 440 million years BP 5.3 million years	Small marine organisms	The causes of this event are still not fully understood, but factors such as climate change, changes in sea level, and a drop in oxygen levels in the oceans are believed to have played a role.
2. Devonian Extinction 365 million years BP 47.8 million years	Tropical marine species	The causes of this event are also uncertain, but possible factors include climate change, sea-level fluctuations, and possibly a series of catastrophic events such as massive volcanic eruptions.
3. Permian-Triassic Extinction 250 million years BP 9.4 million years	Wide range of species, including many vertebrates	The largest mass extinction event in Earth's history. The causes of this event are believed to be a combination of volcanic activity, climate change, and a significant release of greenhouse gases, leading to global warming and ocean acidification.
4. Triassic-Jurassic Extinction 210 million years BP 16.9 million years	Many terrestrial vertebrates	Exact causes are still debated, but possible factors include climate change, volcanic activity, and sea-level fluctuations. This extinction resulted in the rise of dinosaurs.
5. Cretaceous-Tertiary Extinction 65 million years BP 5.1 million years	Dinosaurs and many other species groups	A massive asteroid impact triggering a chain of events, including wildfires, climate change, and the release of dust and debris into the atmosphere.

There remains debate about the timing and trajectory of when pervasive human-mediated extinctions began (Cowie et al. 2022). The expansion of European colonization in the 15th to 17th centuries that triggered in the extinction of island species (e.g., Dodo [*Raphus cucullatus*], c. 1662) and rise of the industrial revolution in the 18th century that resulted in both commercial exploitation and habitat degradation (e.g., Great Auk [*Pinguinus impennis*], 1844) are both reasonable starting periods for the globalization of extinction. The International Union for Conservation of Nature (IUCN) Red List uses the

year 1500 as the cutoff to report on extinction of wild species, however, humans have been driving species loss, and arguably initiated global declines in species richness, millennia earlier. As humans migrated out of Africa 60,000-90,000 years ago, they encountered megafauna that had not evolved with human predation (Koch & Barnosky 2006). In addition to direct hunting, humans also altered ecosystems in ways that likely contributed to the extinction of some species (e.g., O’Keefe et al. 2023). People have been altering terrestrial ecosystems for over 12,000 years (Ellis et al. 2021) and slash and burn agriculture and pastures changed ecosystems on a scale more extensive than the factories of early industrialization (Radkau 2008). The Late Quaternary Megafauna Extinction event (a significant, but not a mass extinction event) occurred between 50,000 to 3,000 years ago. While discerning between the complex interaction between direct human impacts and environmental changes, including climate change, are not fully resolved (Louys et al. 2021) and both likely contributed (Fordham et al. 2024), the magnitude of megafauna extinction is well documented. It resulted in the loss of over 178 of the world’s largest mammals including the loss of 83% of genera in North America (Andermann et al. 2020),

Extinction is interwoven into the broader biodiversity crisis of human mediated environmental planetary change that has been labelled the Anthropocene (e.g., Crutzen 2006). Over three-quarters of the earth’s terrestrial ecosystems (excluding Antarctica) have been directly modified by anthropogenic activities (Ellis et al. 2010), and 70% of the planet’s remaining terrestrial areas of high ecological integrity are now restricted to just five countries (Watson et al. 2018). The human footprint also extends into the oceans with 80% of marine biomes currently impacted by fishing, nutrient run-off, and climate change (Jones et al. 2018). Since the earliest estimates, the extent and condition of natural ecosystems have declined by 47%, with many deteriorating by 4% each decade (Bridgewater et al. 2019). Negative trends have been accelerating and intensifying since about the 1970s and are projected to continue or worsen into the future under business-as-usual scenarios (IPBES 2019).

While debate remains about our current rate of species loss, particularly when compared to past mass extinction events (Bocchi et al. 2022), comparison of fossil and modern extinction data suggests that losing the diversity of species currently threatened with extinction would be similar to another mass extinction event (Barnosky et al. 2011). Current extinction rates are up to one thousand times greater than natural historical levels (De Vos et al. 2015; May & Lawton 1995) and future rates are projected to increase. While there is significant variation, all taxonomic groups are experiencing accelerated extinctions. Globally, over 44,000 species are now assessed as threatened (IUCN 2023b) and up to one million (of an estimated 8.1 million) species are at risk of extinction in the coming decades (Díaz et al. 2019; Tollefson 2019). Many wild species that were previously common are experiencing rapid population declines (Butchart et al. 2010; World Wildlife Fund 2018) including insects (Sánchez-Bayo & Wyckhuys 2019; van Klink et al. 2024) and songbirds (Rosenberg et al. 2019).

Most contemporary extinctions are a result of life history traits that make species vulnerable to human pressures (Nick & Cowlishaw 2004). The combination of natural vulnerabilities with increasing human threats can cause species to decline through an “extinction vortex” (Fagan & Holmes 2006; Gilpin & Soule’ 1986), where “a mutual reinforcement occurs among biotic and abiotic processes that drives population size downward to extinction” (Brook et al. 2008). Threats to wild species vary greatly by geography, taxa, and biomes (Bellard et al. 2022). Globally habitat change is identified the most important driver of biodiversity decline, followed by overexploitation, climate change, pollution, and biological invasions (Díaz et al. 2019; IPBES 2019). Over-exploitation and invasive species are the main drivers of species that have become extinct since 1500 (Bellard et al. 2016), with habitat loss now the main threat to biodiversity. Climate change is predicted to be a major cause of species extinctions in the next century (Cahill et al. 2013; Malanoski et al. 2024; Urban 2024). These threats are often combined

and result in novel pressures and drivers of extinction including trophic cascades and co-extinctions (Diamond 1989).

While the currency of the sixth extinction remains in debate, we have entered a period where biodiversity loss, along with climate change, are recognized as among the defining crises of our time (Dasgupta 2021; IPBES-IPCC 2021; World Economic Forum 2024). Many species are now extinct or threatened because of human activity and future rates of extinction are expected to increase under business-as-usual models (De Vos et al. 2015; May & Lawton 1995). But unlike past extinction events, the magnitude, timing, and most importantly, the reversibility, can be influenced by the very forces that triggered the event. In Canada and around the world, governments, civil societies, and other actors are engaged in efforts to halt and reverse the loss of biodiversity and to bend the curve on our current extinction trajectory.

1.2 CANADA'S BIODIVERSITY

There are an estimated 80,000 wild species in Canada (CESCC 2022) including 3,205 species that have been introduced to Canada by humans. Of the over 24,000 species that have been assigned national conservation ranks by NatureServe, 20% are of conservation concern in Canada. Canada also has 1,527 species of global conservation concern, with the greatest number in BC, Quebec, Ontario, and Alberta (NatureServe 2023). In addition there are 339 species in Canada that are currently assessed as critically endangered, endangered, vulnerable and near threatened on the global IUCN Red List of Threatened Species (IUCN 2022), and over 300 species that are nationally endemic (see **Chapter 3**). While some groups such as birds and vascular plants are well-known, almost 80% of wild species in Canada remain undiscovered or poorly documented (CESCC 2022).

Canada is a vast country that covers 15 terrestrial ecozones and 12 marine ecoregions (Statistics Canada 2018a). From inland temperate rainforests to tallgrass prairies to coastal saltmarshes, there are thousands of different ecosystems described from Canada. There are currently over 1,500 at-risk ecosystems that are ranked as globally vulnerable, imperiled, or collapsed by NatureServe, including 39 globally threatened ecosystems restricted to Canada. Many globally threatened ecosystems provide habitat for multiple species of global and national conservation concern. However, our understanding of the diversity, distribution, and conservation status of Canadian ecosystems is still emerging. Most existing mapping and classifications were developed to support forest inventory mapping or are regional in scope. As a result, many ecosystems remain poorly documented, particularly in northern and eastern Canada. This limits the ability to fully describe, and conserve threatened ecosystems across the country.

Canada's socioecological geography reflects the three 'conditions' of biodiversity conservation and sustainable use (Locke et al. 2019). Canada is one of the few nations that still has large wild areas (Watson et al. 2018), and holds a disproportionate amount of the planet's remaining lakes, wetlands, (Tognelli et al. 2017) and intact ecosystems (Plumptre et al. 2021). The abundance and ecological integrity of Canada's northern regions results in conservation opportunities that have largely disappeared from other nations and the persistence of ecological processes that have a global influence. Canada also has large northern areas subject to historic and increasing pressures from industrial forestry, mining, and hydropower. Over the last 150 years, most of the decline and loss of wildlife (see Chapter 2) has been in southern Canada, which has the longest history of colonization, agricultural, urban and industrial land uses, and is where most Canadians live. For example, only 25% of Canada's prairies remain, southern Ontario has lost 85% of its forest cover, and 70% of southern British Columbia's estuary marshes have been lost or degraded (Federal Provincial and Territorial Governments of Canada 2010).

Habitat loss is the main threat to wildlife in Canada, including species at risk (McCune et al. 2013; Venter et al. 2006). Canada has over 850 wildlife species at risk, an increase of over 150 in just the last decade alone (COSEWIC 2016). Many other wildlife populations are declining (WWF-Canada 2020; WWF Canada 2017). For example, Canadian breeding bird populations have decreased 12% since 1970, and some bird groups, such as grassland birds, aerial insectivores and shorebirds, are showing steep declines of up to 70% (NABCI 2012; NABCI 2019). Protection of Canada's north offers some of the last global opportunities to conserve large, intact landscapes; however, the urgency for conservation is greatest in the south where the human footprint is the highest and continues to expand (Kraus & Hebb 2020).

1.3 THE HISTORY OF BIODIVERSITY CONSERVATION IN CANADA

The current state of wildlife in Canada and our approaches to conservation are part of a long lineage of people and politics within Canada and around the world that has influenced not just biodiversity, but our attitudes and approaches to conservation. The history¹ of endangered species laws, policies, and management in Canada generally follows a parallel trajectory to many other western nations, and in particular, has been influenced by the United States, including the social factors that gave rise to the establishment of national parks (Antadze 2017). In North America, the concept of extinction as a direct result of human activity began to gain acceptance by the mid-1800s (Rowland 2009). This was the result of an increasing number of accounts of drastic declines in wildlife populations due to over-hunting and commercial harvest (such as waterfowl, furbearers and Plains Bison [*Bison bison bison*]) (Mowat 1984). An understanding of wildlife loss and the degradation of habitats was first widely introduced in *Man and Nature* (Marsh 1864). Marsh's book challenged the myth of the inexhaustibility of nature and provided evidence that humans can deplete wildlife and other natural resources. It was published at a time when there was growing civic interest in natural history and calls to protect wildlife, including the founding of the Ottawa Field-Naturalists' Club (1863) and Audubon Society (US) (1866).

Canada's Confederation in 1867 occurred during this tipping point of society's increasing interest, awareness, and concern of wildlife loss, and the mainstreaming of three early responses to reduce the loss of wildlife: game laws, protected areas, and cross-border conservation. These eventually led to the emergence of endangered species legislation in Canada.

The first game law in Canada was introduced in 1762 to declare a closed season on partridge (Ruffed Grouse [*Bonasa umbellus*]) in Upper Canada, and in 1839 the first comprehensive game laws were introduced in Ontario (Foster 1998). The founding of sportsman clubs began in the middle of the 19th century in Canada and the US, including in 1852 when Officers at the Halifax Garrison in Nova Scotia encouraged urban sportsmen to organize a Game and Inland Fishery Protection Society. The local government authorized the club to enforce wildlife protection laws in 1884, in what may be the first example of systematic enforcement of game laws in North America (Egerton 2019; Loo 2011).

Wildlife conservation laws in Canada began in the east because of decreasing numbers of game species, such as Elk (*Cervus canadensis*) and Wild Turkey (*Meleagris gallopavo*). However, the loss of wildlife from Canada's west and north was well also underway by Confederation. In 1895 the *Unorganized Territories Game Preservation Act* was passed by Parliament that introduced seasons and limits, and a five-year moratorium on hunting Wood Bison (*Bison bison athabasca*) (Foster 1998). The Hudson Bay Company also developed and enacted pioneering conservation programs to preserve plummeting North American Beaver (*Castor canadensis*) populations in the early nineteenth century including harvest

¹ See Canada's conservation timeline created for my research at:
<https://www.tiki-toki.com/timeline/entry/1178311/Canadian-Conservation/>

quotas and gear restrictions, trading post closures in trapped out areas, and created some of the earliest furbearer sanctuaries in North America (Sandlos 2013).

Parallel to the introduction of game laws in Canada was the establishment of protected areas. Canada was significantly influenced by the creation of national parks in the US including Yellowstone National Park, established in 1872 (although it took another 22 years before hunting was prohibited in the park) (Foster 1998). Canada followed with Banff National Park in 1885 (originally named Banff Hot Springs Reserve and later the Rocky Mountains National Park), three additional Rocky Mountain parks between 1886-1895, and Algonquin Provincial Park in 1893 (originally called Algonquin National Park). These first 'national' parks were established for a variety of reasons, including recreation and economic development. These early protected areas also removed and excluded Indigenous Peoples from their traditional territories (Binnema & Niemi 2006). While Algonquin 'National' Park was partially established to protect furbearers (MacKay 2018), the first protected area in North America established solely to conserve wildlife was Last Mountain Lake Migratory Bird Sanctuary in Saskatchewan in 1887. The US system of national wildlife refuges was not established for another 16 years on Pelican Island in Florida. Systems of protected areas expanded quickly in both countries. By 1910 the US had 50 additional refuges, and the Canadian provinces started to develop their own protected area systems. Canada established the world's first national parks service in 1911 (then called Dominion Parks Branch) (Foster 1998), and a 77 years later pioneered ecological integrity as the first priority for the management of national parks (Woodley 2010).

Many of Canada's first protected areas were critical for the protection and recovery of game animals including North American Beaver (Algonquin Provincial Park, est. 1893), Plains Bison (Buffalo National Park, est. 1909, closed 1940), Elk (Elk Island National Park, est. 1913), waterfowl and other migratory birds (Point Pelee National Park, est. 1918), Wood Bison (Wood Buffalo National Park, est. 1922), and Pronghorn (Menissawok National Park, est. 1922, closed 1930). As explored in **Chapter 2**, while most of these species are common and not at risk of extinction today because of these early conservation actions, many were Canada's among most endangered species at the turn of the nineteenth century.

As new game laws and protected areas were beginning to establish, there was growing recognition that comprehensive national and international regulations were needed to coordinate the management and conservation of wildlife across provincial and national borders. The federal Fisheries Act (1868) was intended to coordinate the conservation of fishes and fish habitat across Canada. The first international treaty in North America to manage wildlife populations was the *North Pacific Fur Seal Convention*, between the US, Canada (signed by the UK), Japan, and Russia in 1911. In response to rapidly declining populations the treaty included a five-year moratorium on hunting, and a ban on pelagic hunting during migration. In the early 1900s there was increasing pressure from civil societies (e.g., Audubon Club) and scientific authorities (e.g., Hornaday 1913) to protect migratory bird populations. Although there were emerging state and provincial wildlife laws, large numbers of migratory birds were being killed by commercial hunters and for the plume trade (Doughty 1975). The *Migratory Bird Convention*, between the US and Canada in 1916 helped to strengthen wildlife conservation laws across Canada (Green 1976). In addition to limits, seasons and temporary bans on some species, the federal government assumed responsibility of migratory birds, and established the Canadian Wildlife Service (founded as the Dominion Wildlife Service in 1947) (Burnett 2003).

Although Canada had several legislative tools to manage wildlife in the 20th century, it did not have a federal wildlife policy until 1973 when the *Canada Wildlife Act* received royal assent - the same year Canada signed the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) and the US *Endangered Species Act* was enacted (Hoffman 2018). The Act enabled the creation of National Wildlife Areas and gave new authority to the federal government to manage and protect

wildlife and enable research and conservation of wildlife, particularly those at risk. Following a symposium on Canada's threatened species and habitats (Mosquin & Suchal 1977) and a Conference of Federal-Provincial-Territorial Wildlife Directors in 1976, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was formed in 1977 as an independent national committee to provide science advice on the status of species. COSEWIC's first assessments of endangered wildlife focused on mammals and birds, with the first plant assessment in 1980 (Furbish's Lousewort [*Pedicularis furbishiae*] (see **section 1.6** for additional discussion on COSEWIC).

Although there was no federal endangered species act after the founding of COSEWIC, there was federal coordination of species protection and recovery. The Recovery of Nationally Endangered Wildlife (RENEW) was launched in 1988 by the Wildlife Minister's Council of Canada to support the coordinated recovery of species at risk. RENEW had no legal force, but over its history produced annual reports, established 31 recovery teams, and approved recovery plans for 13 species (Scudder 1999).

Canada's efforts to conserve non-game wildlife was part of a global shift towards valuing and protecting the diversity of life. The concept of 'biological diversity' (later shortened to 'biodiversity') has its origins in western science in publications that range from Aldo Leopold's Sand County Almanac (*The first rule of intelligent tinkering is to keep all the pieces*) (Leopold 1949) to literature in the 1960s and 1970s including *Silent Spring* (Carson 1962), which catalyzed the environmental movement and helped establish the US Environmental Protection Agency and Earth Day; and *Conserving Life on Earth* (Ehrenfeld 1972) and *The Sinking Ark* (Myers 1979), both of which highlighted the looming extinction crisis and estimated rates of species loss. Biological diversity and extinction were the focus of the US Council on Environmental Quality (Council on Environmental Quality 1980) and the 1986 National Forum on Biodiversity that advanced the concept and issues of the loss of biological diversity to the public and decision-makers (Tangley 1986). This rise of awareness of biodiversity set the stage for the global *Convention on Biological Diversity* in 1992 and Canada's *Species at Risk Act* a decade later.

1.4 THE CONVENTION ON BIOLOGICAL DIVERSITY AND CANADA'S SPECIES AT RISK ACT

Canada's Species at Risk Act (SARA) (2002) was a commitment in Canada's Biodiversity Strategy (Environment Canada 1995) - the federal response after ratifying the United Nations Convention on Biological Diversity (CBD) in 1993 (signed in 1992). The CBD has three main objectives: the conservation of biological diversity; the sustainable use of the components of biological diversity, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. Through the CBD, Canada made a commitment to "promote the recovery of threatened species" (Article 8) (UN 1992).

While the CBD made biodiversity, including threatened species, a national interest, the federal government needed to work within Canada's existing constitutional framework for implementation. In preparation for SARA, federal, provincial, and territorial ministers responsible for wildlife signed the *Accord for the Protection of Species at Risk* in 1996, except for Nunavut (which did not yet exist) and Quebec. The Accord is non-binding, but established a set of agreed principles including cooperation, scientific assessment, the inclusion of all wild species, and a recovery process.

A major challenge to federal action in species at risk and biodiversity conservation is the constitutional division of powers (Campbell & Thomas 2002) and understanding the design and implementation of SARA requires a brief review of the structure of federal governance. Canada is both a constitutional monarchy and a parliamentary democracy with powers divided between the federal and the provincial and territorial governments. The federal government is principally responsible for issues of national

concern such as trade and defence. Under the Canadian Constitution, the federal government also controls the existence and powers of territorial governments. However, the devolution of federal powers, or the transfer of province-like responsibilities to territorial governments, is now complete with agreements finalized in Yukon (2003), the Northwest Territories (2014), and the Nunavut Lands and Resources Devolution Agreement in 2024. Provinces and territories have jurisdiction over matters such as mining and forestry on Crown Lands and land use planning. Federal, provincial, and territorial governments participate in intergovernmental discussions on environmental matters of shared interest and jurisdiction. Matters related to species at risk are discussed via an ad hoc forum of federal, provincial, and territorial (FTP) Ministers responsible for conservation, wildlife, and biodiversity¹.

Legal authority for species at risk in Canada is based on jurisdictional responsibility. This federal, provincial and territorial power structure overlaps and can be blurred. The federal government has limited jurisdiction of biodiversity in the provinces and territories and its authority is primarily restricted species that are subject to federal laws. This limits the federal authority of species at risk to migratory birds (*Migratory Birds Convention Act*), aquatic species (*Fisheries Act*), and species found on federal lands (e.g., national parks, national wildlife areas, military bases). Most terrestrial species at risk occur on private lands, provincial Crown Lands, and territorial lands, and are the responsibility of provinces and territories. Federal and provincial/territorial governments can enter into conservation agreements under SARA and the *Canadian Wildlife Act* to conserve species at risk. There are currently 15 conservation agreements under SARA (14 for different caribou populations and one for Southern Resident Killer Whale) (Government of Canada 2025). Nature Agreements have also been introduced to coordinate actions and financial commitments on species at risk. Currently, only BC, Nova Scotia, and Yukon have Nature Agreements with the federal government (Government of Canada 2024).

Federal responsibilities for implementing SARA are also shared among federal authorities. The Ministry of Environment and Climate Change (ECCC) (Canadian Wildlife Service) is responsible for the overall coordination of the federal species at risk strategy and the protection and recovery of migratory birds. Fisheries and Oceans Canada (DFO) is responsible for the protection and recovery of aquatic species at risk under federal jurisdiction. Parks Canada (an agency of ECCC) is responsible for the development of recovery strategies for those species that primarily occur in national parks, national historic sites, and other federal protected heritage areas. These authorities can form agreements with other federal departments to support the purpose of SARA, (e.g., *Cooperation on Terrestrial Species at Risk matters Under the Responsibility of the Minister of Environment and Present on Defence Establishments*, 2011).

SARA has three purposes (s.6): 1) to prevent wildlife species from being extirpated or becoming extinct, 2) to provide for the recovery of wildlife species that are extirpated, endangered, or threatened because of human activity, and 3) to manage species of special concern to prevent them from becoming endangered or threatened. Under SARA, 'wildlife species' are defined as 'a species, subspecies, variety or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and native to Canada; or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years'. Thus, while SARA is a species at risk act, the legislation also includes genetic diversity by encompassing infraspecies (subspecies, varieties, or geographically or genetically distinct populations).

To meet the purposes of SARA, ECCC has mapped out Canada's species at risk conservation cycle with five main components: assessment, protection, recovery planning, implementation, and monitoring and evaluation (ECCC 2018a) (**Table 2**).

¹ Quebec participates in meetings of FTP ministers responsible for conservation, wildlife, and biodiversity as an observer.

Table 2: Canada's species at risk conservation cycle

1. Assessment • COSEWIC (Committee on the Status of Endangered Wildlife in Canada): This independent committee of experts identifies and assesses species that may be at risk using standard criteria that are based on IUCN Red List criteria. • COSEWIC conducts detailed scientific assessments to determine the status of species using the best available information, including scientific data, community knowledge, and Aboriginal traditional knowledge. • Based on its assessment, COSEWIC assigns a status to each species: extinct, extirpated, endangered, threatened, special concern, not at risk, or data deficient.
2. Legal Listing & Protection • COSEWIC submits its assessment to the federal Minister of Environment and Climate Change. • The federal government reviews COSEWIC's recommendations and considers various factors including potential socio-economic impacts. This review can involve public consultations. • The federal Cabinet then decides whether to add the species to the List of Wildlife Species at Risk under SARA. • Once listed, species receive legal protections under SARA. Protections vary depending on the species' status and jurisdictional responsibilities. • Prohibitions may include bans on killing, harming, harassing, capturing, or taking individuals of the species, as well as on the destruction of their critical habitat.
3. Recovery Planning • Recovery planning under SARA is a collaborative process that involves the federal government, provincial and territorial governments, Indigenous Peoples, and stakeholders. The recovery process begins with the assessment of a species' status, which includes an evaluation of its distribution, population size, and the threats to its survival. • For species listed as extirpated, endangered, or threatened, the government must prepare and make public a recovery strategy and one or more action plans. • A recovery strategy includes a determination of whether recovery is feasible. If recovery is determined to be feasible, the recovery strategy must address threats to the survival of the species identified by COSEWIC. • The recovery strategies must describe the species and its needs, identify threats to its survival, identify critical habitat, if possible, it outlines activities that could destroy this habitat, set recovery goals and approaches, highlight information gaps, and specify timelines for action plans. It must also present other specific elements as outlined in SARA Section 41 including population and distribution objectives. • A proposed recovery strategy must be posted on the Species at Risk public registry within one year of the corresponding listing on SARA Schedule 1 for endangered species, and within two years for threatened or extirpated species. • For species of special concern, a management plan must be prepared within three years of listing. It must include measures for the conservation of the species and may apply to more than one wildlife species. A management plan differs from a recovery strategy and action plan, as it sets goals and objectives for maintaining sustainable population levels of one or more species that are particularly sensitive to environmental factors, but which are not in danger of becoming extinct. • Action plans outline detailed, specific measures and actions necessary to achieve the recovery goals and objectives for species at risk, including timelines, and responsible parties.
4. Implementation • Governments, organizations, and individuals implement the actions outlined in recovery strategies and management plans to improve the conservation status of the species. These actions can include habitat restoration, protection measures, research, monitoring, and public education. • The federal Habitat Stewardship Program (HSP) funds projects that conserve and protect species at risk and their habitats by supporting stewardship efforts undertaken by various organizations and individuals.
5. Monitoring and Evaluation • Continuous monitoring of the species and its habitat is conducted to evaluate the effectiveness of recovery actions and the species' status over time. • Regular reports are produced to update on the status of recovery efforts and to adjust actions as needed. • COSEWIC periodically (generally every ten years) reassesses the status of listed species to determine if their condition has improved, worsened, or remained stable. • Based on these reassessments, species can be reclassified, or the focus of recovery efforts can be adapted.

Based on ECCC 2018a.

One of the key challenges of implementing SARA is that many other federal, provincial, and territorial departments and policies influence wildlife and habitats, and can conflict with the purpose of SARA. These nature-related policies that can mitigate, or cause, threats to species at risk are interwoven into a myriad of federal, provincial, and territorial responsibilities that are complex to navigate and coordinate. For example, while the federal government is responsible for potential threats such as shipping, international pollution, and wildlife trade, provinces and territories manage industrial activity and most domestic pollution, and resource development. Some threats have a shared responsibility including invasive species and greenhouse gas emissions. Environmental assessments generally fall under provincial and territorial responsibility, unless a project is expected to have an effect within federal jurisdiction such as migratory birds or species at risk. While a decision by the Supreme Court in 2023 found that some aspects of the federal *Impact Assessment Act* are unconstitutional and infringes on the powers of provinces which may limit future requirements for federal assessments ("Impact Assessment Act" 2023), SARA still applies to provincial environmental assessments.

The complex jurisdictional responsibilities and powers underlying SARA often surface during implementation of the Act. Automatic protections for species listed under SARA apply only to migratory birds, aquatic species, and species on federal lands (i.e., species under federal authority). Hence, protection for most species at risk and their habitats is the responsibility of provincial and territorial governments. However, the federal government has two key options it can enact under SARA if provincial and territorial protections are ineffective. An 'emergency order' (s. 80) can protect any species on non-federal lands. This can be issued by Cabinet when a species faces "imminent threats" to its survival or recovery. To date, the federal government has only issued two emergency orders (Greater Sage-grouse [*Centrocercus urophasianus*] and Western Chorus Frog [*Pseudacris triseriata*]). SARA also includes a "safety net" provision (s. 34, 35). If the laws of a province or territory are not effectively protecting a listed species or its residence, the federal government can activate the "basic prohibitions safety net" or the "critical habitat safety net". But these safety net provisions have never been exercised. This hesitancy of the federal government to enact discretionary power is not uncommon in other examples of environmental legislation in Canada (Smallwood 2003). As a result, there is often significant variation, and tension, in how provinces and territories interpret and implement SARA.

While provincial and territorial species at risk legislation was intended to complement SARA, there remains a patchwork of protection measures for most species through differing provincial and territorial interpretations and implementation of SARA (Olive 2015) (**Appendix 1**). When the National Accord for the Protection of Species at Risk was signed in 1996, only Ontario (1971), New Brunswick (1973), Quebec (1989) (not a signatory to the Accord), and Manitoba (1990) had endangered species laws in place. Following the Accord, Nova Scotia (1998), Newfoundland and Labrador (2001) and Northwest Territories (2009) enacted new laws and Ontario (2007), and New Brunswick (2013) revised existing endangered species legislation. BC, Alberta, Saskatchewan, Yukon, Nunavut, and PEI still do not have dedicated species at risk legislation. Provinces and territories that do not have dedicated species at risk laws use wildlife laws that give authority for protection of designated imperiled species, but generally not for their habitats (Ecojustice 2012; Olive 2018).

This policy patchwork results in variable and inconsistent listing and protection of species at risk (Wojciechowski et al. 2011). Many species are often listed under SARA but are not included in provincial or territorial listings, which can limit the scope of recovery efforts (e.g., Bobolink [*Dolichonyx oryzivorus*] is listed under SARA, but not in Manitoba's *Endangered Species and Ecosystems Act*). The timing and coordination of assessments with COSEWIC is also not consistent. While some jurisdictions such as Ontario update the list of species under the province's *Endangered Species Act* on a regular basis based on COSEWIC assessments, New Brunswick's updates to its *Species at Risk Act* in 2022 were the first

updates since the amended legislation can into effect in 2013. Quebec also updated its list of vulnerable and threatened species in 2022, the first update since 2009. There can also be a lack of recovery planning coordination. For example, Hare-footed Locoweed (*Oxytropis lagopus*), a prairie wildflower with a Canadian range that is restricted to Alberta is listed on Schedule 1 of SARA as threatened, with no recovery strategy. In Alberta, this same species is assessed as special concern by the province, and a *Conservation Management Plan* was developed in 2016 (Alberta Environment and Parks 2016), two years before it was listed as threatened under SARA.

The Pan-Canadian Approach to Species at Risk Conservation was introduced in 2018 as a collaborative framework adopted by federal, provincial, and territorial governments to address the conservation of species at risk across the country. It emphasizes cooperation, coordination, and shared responsibility among jurisdictions to conserve and protect Canada's biodiversity and calls for a 'transformative approach to operationalizing species at risk conservation' (ECCC 2018b). As part of this transformation the pan-Canadian approach has identified priority places, priority species and priority threats and sectors, and the goals include better outcomes for species at risk and increased co-benefits for biodiversity and ecosystems. This approach is a central component to species at risk conservation in Canada's 2030 Nature Strategy (ECCC 2024a) (see **section 1.5.5**).

The implementation history of species at risk laws in Canada has generally been weak and politically contentious. Changes to endangered species legislation to reduce protection under the auspices of efficiency and removal of 'red tape' is a common and reoccurring event (e.g., Bergman et al., 2020; East Coast Environmental Law 2021). The *Ontario Endangered Species Act*, for example, has been amended six times since it was assented to in 2007 – four times since 2019. While once considered the strongest of such laws in force in Canada (Ecojustice 2012), a recent audit found Ontario's Act was failing to achieve its central purpose, with mounting evidence for weakened and delayed protections for species at risk (Auditor General of Ontario 2021). SARA is also proving to be politically charged, and its effective implementation is often a casualty to the power and politics of the federation. The federal government is hesitant to criticize provincial and territorial implementation of SARA, such as annual reports on critical habitat protections (ECCC 2019d), and some provinces refuse to develop Nature Agreements with the federal government, despite a commitment in the Accord for cooperation.

While governments may be reticent to enforce species at risk laws, when they are applied and subsequently challenged, they are held up by the courts. In 2022, the Ontario Court of Appeal upheld a conviction of the Town of South Bruce Peninsula's for damaging the habitat of the endangered Piping Plover (*Charadrius melodus*) at Sauble Beach on the shores of Lake Huron. In 2019, the town was convicted on two charges of damaging habitat, contrary to Section 10(1) of the ESA that makes it an offence to damage or destroy an endangered or threatened species' habitat by using heavy equipment to level beach and dunes where this shorebird nests. The Court of Appeal found that the ESA should be given a generous interpretation considering its remedial nature and objective of environmental protection. It further found that 'the statutory regime creates an absolute prohibition against damage to the habitat of an endangered species' (Langlois 2019). Federally, the Supreme Court ruled in 2018 that ECCC had the right to stop a development in Quebec that would destroy critical habitat of the threatened Western Chorus Frog (*Pseudacris triseriata*). This is one of just a few cases where the federal government issued an emergency order (SOR/2016-211) under the *Species at Risk Act* section 80 and subsection 97(2)). The court found the legislative provision of SARA was not 'ultra vires Parliament' (i.e., not beyond the powers of the federal government) and that the emergency order was not a form of expropriation without compensation ("Groupe Maison Candiac Inc. v. Attorney General of Canada, et al." 2020). While it might be expected that judiciary support for species at risk laws would bolster more diligent application of SARA, the federal government continues to threaten their enforcement (e.g., development proposals in Ontario's Greenbelt), but have avoided legal proceedings.

1.5 OTHER TOOLS & ENABLERS TO CONSERVE SPECIES AT RISK

While Canada's *Species at Risk Act* is the primary legislation to protect endangered species, there are other tools and enablers that support species at risk conservation. International treaties and other laws also provide protection of species at risk and their habitats. Protected and conserved areas continue to play a foundational role in conserving some species at risk, while the emerging directions of Indigenous-led conservation may accelerate wildlife conservation. There is also growing recognition from actors outside of traditional conservation about the links between nature loss and other risks, including climate change. Approaches to species at risk conservation are also being influenced by changing public attitudes about nature. Past and emerging tools and enablers to conserve species at risk are also culminating in Canada's 2030 Biodiversity Strategy which strives to halt and reverse the loss of nature through transformative approaches.

1.5.1 INTERNATIONAL TREATIES AND AGREEMENTS

For over a century, international treaties and agreements have supported biodiversity conservation in Canada. In many cases, these instruments have been the foundation for domestic legislation. For example, the *Convention on Biological Diversity* (1992) led to the *Species at Risk Act* (2002), and the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) (1970), sparked the *Canada Wildlife Act* (1973) and the formation of the Committee on the Status of Endangered Wildlife in Canada (1977).

While Canada's first biodiversity related treaties and agreements focused on reducing overexploitation, the evolution of international cooperation to protect nature has expanded to wetland and world heritage sites, and finally biodiversity with Canada's continued ratification of the CBD in the recent adoption of the Kunming-Montreal Biodiversity Framework in 2022 (see **section 1.5.7**). Canada currently participates in 26 international agreements and instruments related to biodiversity and ecosystems. These range from a legally binding treaty with the US on the Conservation of the Porcupine Caribou Herd to a multilateral financial mechanism to support the Global Biodiversity Information Facility. Other international agreements and instruments abate threats to biodiversity including the London Protocol on Prevention of Marine Pollution and the United Nation Framework Convention on Climate Change and its Paris Agreement (**Table 3**). In addition, Canada has pledged to join the Bonn Challenge for Landscape Restoration, and while not a signatory, Canada follows the Convention on the Conservation of Migratory Species of Wild Animals. Canada's engagement in international nature-related agreements is generally led by ECCC, with support from Global Affairs Canada.

In addition to international treaties and agreements, Canada also adopted the UN's 2030 Sustainable Development Goals (SDGs) (UN 2018). Two of these goals are particularly relevant for biodiversity. Goal 15 (Life on Land) aims to protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, and halt and reverse land degradation. Goal 14 (Life Below Water) promotes the conservation and sustainable use of the oceans and marine resources. The federal government recognized that implementation of the SDG goals will require 'whole-of-government' and 'whole-of-society' approaches (Government of Canada 2021), which have now been incorporated into Canada's 2030 Biodiversity Strategy. In collaboration with federal departments and agencies, Statistics Canada has developed the Canadian Indicator Framework (CIF) for the SDGs. The CIF includes 76 indicators specific to Canada (indicators are discussed in **section 1.6**).

Table 3: Key biodiversity-related environmental treaties and agreements

Treaty/ Agreement Date signed by Canada	Purpose/Objective
Convention for the Protection of Migratory Birds August 16, 1916 Amending Protocol signed: December 14, 1995	The Convention extends protection to migratory birds in Canada and the United States and provides for the management of migratory bird species through sustainable hunting, and conservation of migratory bird populations.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) April 10, 1975	Ensure that international trade in wild animals and plants does not threaten their survival. CITES provides a framework for regulating and monitoring trade through a system of permits and certificates, protecting over 38,000 species from over-exploitation while allowing for sustainable use and conservation of wildlife.
World Heritage Convention July 23, 1976	The Convention sets out the duties of States Parties in identifying potential sites and their role in protecting and preserving them. By signing the Convention, each country pledges to conserve not only the World Heritage sites situated on its territory, but also to protect its national heritage.
Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar) June 2, 1983	The objective of the Ramsar Convention is the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world.
Convention on Biological Diversity (CBD) November 6, 1992 Canada adopted the Kunming-Montreal Global Biodiversity Framework on December 20, 2023	There are three objectives to this agreement: the conservation of biological diversity, the sustainable use of the components of biological diversity and, the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.
United Nation Framework Convention on Climate Change (UNFCCC) and the Paris Agreement June 12, 1992	The ultimate objective of the UNFCCC is to ‘stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system’. The UNFCCC Paris Agreement aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty. COP28 in 2023 included a Joint Statement on Climate, Nature and People that was endorsed by 18 countries including Canada, that recognizes that the problems of climate change, biodiversity loss, land degradation ocean degradation and social inequality are interconnected and cannot be solved separately and the signers pledge to unify the plans to solve the problems into one integrated strategy.
Commission for Environmental Cooperation (CEC) September 8-14, 1993	In the context of environmental, economic, and social linkages between Canada, Mexico and the United States, the CEC facilitates effective cooperation and public participation to conserve, protect and enhance the North American environment in support of sustainable development for the benefit of present and future generations.
North American Bird Conservation Initiative (NABCI) June 22, 2005	NABCI’s objective is to facilitate the conservation of North American birds and their habitats. NABCI was formed in 1998 after a resolution by the CEC council and in 2005 Canada, Mexico and the US signed a Declaration of Intent for ‘the Conservation of North American Birds and their Habitat’.
United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (the BBNJ Agreement) March 4, 2023	The BBNJ Agreement’s objective is to ensure the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, for the present and in the long term, through effective implementation of the relevant provisions of the United Nations Convention on Law of the Sea and further international cooperation and coordination.

1.5.2 OTHER BIODIVERSITY LAWS

SARA and provincial and territorial legislation to protect species at risk are part of a diverse suite of approximately 100 laws across Canada that directly or indirectly protect biodiversity. However, none provide comprehensive protection for wildlife and wildlife habitats and are generally focused on protected areas, and the management of game animals and fish (Ray et al. 2021). As with species at risk, biodiversity governance in Canada is complex and a shared responsibility and the Government of Canada leads various federal-provincial-territorial-Indigenous working groups or councils to coordinate actions.

All biodiversity-related laws under federal jurisdiction are the responsibility of Environment and Climate Change Canada and Fisheries and Oceans Canada (*Fisheries Act*). The federal *Forestry Act*, under the responsibility of Natural Resource Canada (Canadian Forest Service) has a focus on research and development, although two large research forests under federal authority were established under this Act (Petawawa in Ontario and Acadia in New Brunswick).

While all provinces and territories have biodiversity laws, nature is managed through a patchwork of inconsistent laws throughout the federation. Ontario has 14 biodiversity-related laws while Yukon has only two (Ray et al. 2021). Half of Ontario's biodiversity laws focus on important ecological areas, providing some protection measures to species at risk (e.g., *Greenbelt Act*). Nova Scotia is the only province or territory with a law dedicated to biodiversity: *The Act to Provide for the Conservation and Sustainable Use of Biodiversity in Nova Scotia* (2021). Ontario has a biodiversity strategy, although this is not a law and led by the Ontario Biodiversity Council, a coalition of environmental and conservation organizations, government, academia, industry, and Indigenous communities and organizations. Several provinces (e.g., Quebec, Alberta) are developing biodiversity strategies to support Canada's 2030 Nature Strategy. In addition to laws that are directly related to biodiversity, there are also many natural resource and pollution laws, and planning and impact assessment acts in all jurisdictions of Canada that have provisions that can influence biodiversity outcomes (Ray et al. 2021).

There is emerging legislation that could influence biodiversity conservation in Canada. In 2024, the Government of Canada committed to introduce a federal nature accountability bill. The bill, modeled on the *Canadian Net-Zero Emissions Accountability Act* enacted in 2021, will establish an accountability framework for the federal government in fulfilling its commitments under the Kunming-Montreal Global Biodiversity Framework (KMGBF). The bill would provide concrete steps to implement KMGBF commitments at the federal level, which would include requirements to report on implementation of Canada's 2030 Biodiversity Strategy (see **section 1.5.7**). There is also a Parliamentary Petition e4673 seeking a new *Nature and Biodiversity Act* (closed for signature March 14, 2024). This proposed Act goes further than the nature accountability bill by enshrining the KMGBF goals and targets in legislation and establishes accountability links to other federal laws such as the *Species at Risk Act* and *Impact Assessment Act* without amending those laws.

1.5.3 PROTECTED & CONSERVED AREAS

Many of Canada's firsts protected areas including Elk Island, Wood Buffalo, and Point Pelee national parks were all established with the primary purpose of protecting what were then rare and declining wildlife species and protected and conserved areas continue to play a foundational role in conserving the habitat of species at risk.

Through the KMGBF, Canada has committed to conserve 30% of lands and oceans by 2030 (30x30). To reach 30%, Canada and most provinces and territories will need to grow their systems of protected and conserved areas faster than at any time in their history. Currently, Canada is just less than half-way to

reaching 30% at 13.5%. British Columbia and Yukon are the closest (both over 19%) and New Brunswick and Prince Edward Island have the lowest coverage of protected and conserved areas (both under 5%). While all of Canada's ecozones have some level of protection, ranging from less than 1% to almost 40%, (ECCC 2021a), many ecozones with the highest biodiversity and threats have the lowest coverage of protected and conserved areas (Kraus & Hebb 2020).

In addition to the area of protected and conserved lands and waters, the KMGBF (Target 3) also includes qualitative aspects including connectivity and areas of particular importance for biodiversity that will be critical to leverage protected and conserved areas to support species at risk conservation. However, past numerical targets for protected and conserved areas have tended to focus on quantity over quality. In part this is because area-based aspects of the target can be measured more directly (Green et al. 2019).

Historically, protected and conserved areas establishment was the sole responsibility of governments. These government-protected areas are enabled by supporting legislation. For example, the federal government has the mandate to establish National Wildlife Areas under the *Canada Wildlife Act* (1973), and Ontario's *Provincial Parks and Conservation Reserves Act* (2006) enables the province to create and manage provincial parks. There is more recent recognition that place-based conservation can also be led by non-governmental actors through the establishment of both protected areas and Other Effective Area-based Conservation Measures (OECMs or 'conserved areas') (IUCN-WCPA Task Force on OECMs 2019). While Canada's official reporting on protected and conserved areas was once limited to government (ECCC 2021a), lands owned and managed by land trusts (e.g., Nature Conservancy of Canada, Nova Scotia Nature Trust), municipalities (e.g., City of Kitchener, City of Saskatoon), and industry (J.D. Irving) are now counted as contributions to Canada's 30x 30 target.

1.5.4 INDIGENOUS-LED CONSERVATION

Perhaps one of the greatest transformations of conservation in Canada has been the reinstatement of agency to Indigenous Peoples in managing lands, waters, and wildlife. The early history of conservation in Canada included evicting Indigenous Peoples from their territories to establish protected areas and prohibiting hunting and traditional management practices. However, today Indigenous Peoples are rapidly becoming leaders in biodiversity conservation.

This growing leadership is a combination of increased recognition of the linkages between conservation and reconciliation (Indigenous Circle of Experts 2018), the importance of traditional stewardship practices for supporting biodiversity (e.g., Deur et al. 2015), and the high diversity of species on Indigenous-managed lands (Schuster et al. 2019). The central role of Indigenous-led conservation is increasingly acknowledged, including Indigenous Protected and Conserved Areas (IPCAs) in meeting Canada's targets for conserved areas (Zurba et al. 2019). Several IPCAs have already been established in Canada. The three IPCAs recognized by the federal government are all located in the Northwest Territories: Edézhíe Dehcho Protected Area and National Wildlife Area, Thaidene Nene National Park Reserve and Ts'udé Niljné Tuyeta Indigenous and Territorial Protected Area. BC now has several Tribal Parks and Indigenous Protected and Conserved Areas (e.g., Hada and Kakweikan). More than 50 Indigenous communities across the country have now received funding to establish IPCAs (Mansuy et al. 2023) and the most recent federal budget contains funding for at least another 27 IPCAs. IPCAs are often established on traditional lands that remain as Crown Land under the jurisdiction of provinces. Currently, some provinces such as BC and Manitoba are very supportive of IPCAs, while Saskatchewan and Ontario have created barriers to the establishment of IPCAs.

Voices of Indigenous peoples are also included in decision-making regarding species at risk. COSEWIC now includes an Aboriginal Traditional Knowledge subcommittee, and the National Aboriginal Council on

Species at Risk provides advice to the Minister of ECCC on implementing SARA. There is also a increasing role for Indigenous Guardian programs in conservation (Reed et al. 2021). Indigenous Guardians funding provides Indigenous Peoples with a greater opportunity to exercise responsibility in stewardship of their traditional lands. The federal government in Canada has invested and committed over \$125 million to support Indigenous Guardian programs since 2017.

1.5.5 BIODIVERSITY, CLIMATE CHANGE & ECOSYSTEMS SERVICES

Despite over a century of concern about the loss of nature, the climate crisis quickly overtook nature as a key public issue (Legagneux et al. 2018). However, there has been increased recognition that climate change and biodiversity loss are connected crises that cannot be solved independently. Biodiversity is affected by climate change, with negative consequences for human well-being, but biodiversity, through the ecosystem services it supports, also makes important contributions to climate change mitigation and adaptation. Consequently, conserving and sustainably managing biodiversity support efforts to address climate change (Shin et al. 2022).

The first joint Intergovernmental Panel on Climate Change and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPCC/IPBES) report (Pörtner et al. 2021), focused on exploring connections between climate and biodiversity. It concluded that actions narrowly focused on climate mitigation and adaptation can have negative impacts on nature and treating climate, biodiversity and human society as coupled systems is key to successful outcomes from policy interventions. Recognition of these connections was strengthened through statements at COP28 when 18 countries, including Canada, endorsed the Joint Statement on Climate, Nature and People, placing nature at the center of climate action. Much of this integration can be done through nature-based solutions (Griscom et al. 2017; Mansuy et al. 2023; Sreekar et al. 2022). For example, conserving northern forests and peatlands in Canada will protect critical habitat for the threatened Woodland Caribou (*Rangifer tarandus*) (boreal population) and also help to prevent the carbon from being released into the atmosphere (Sothe et al. 2022).

The co-benefits of biodiversity conservation extend well beyond climate. Recently more than 200 medical journals called on the World Health Organization to deem two overlapping environmental crises — climate change and biodiversity loss — as a global health emergency (Abbasi et al. 2023) and the World Economic Forum identified that the top four risks faced by people are all environmental including extreme weather events from climate change, biodiversity loss, and critical changes to Earth's systems (World Economic Forum 2024). There are a growing number of global assessments on the linkages between biodiversity and human well-being, and the essential ecological goods and services nature provides, including food, water, climate regulation, protection, recreation, and cultural and spiritual benefits that have increased the awareness and appreciation of our reliance on nature (Costanza et al. 1997; Dasgupta 2021; de Groot et al. 2012; Millennium Ecosystem Assessment 2003). There is also growing awareness that while some ecosystem services can be monetized, most of nature's contributions to people are not fully replaceable (IPBES 2019) and that society should be aiming for ecosystem health stewardship to maintain and improve ecosystem services (Hernández-Blanco et al. 2022).

Despite the increasing recognition of the essential role of nature and ecosystem services, biodiversity loss and critical changes to Earth's systems continue to be caused human activities (e.g., IPBES 2019; Richardson et al. 2023; Steffen et al. 2015). However, some of the most significant advancements in biodiversity conservation have come when societies clearly perceive risks and those risks also include human well-being (e.g., Carson 1962). Calls for conservation action from economists and health care signal an important shift in the mainstreaming of biodiversity. As biodiversity loss continues to receive

more attention and is linked to both climate change and health, public attitudes can shift which can trigger changes to politics and policy.

1.5.6 CANADIAN ATTITUDES ABOUT BIODIVERSITY CONSERVATION

Biodiversity conservation, either through protected areas, laws, or a national biodiversity strategy, are ultimately the result of public support or apathy, and what the nation considers to be important to its constituents and citizens (Swerdfager & Olive 2023). While nature is not often at the top of political agenda, except for climate change, there is generally a high degree of support for biodiversity conservation. Over 90% of Canadians agree that protected areas are important, and the top reason is for wildlife conservation (Canadian Parks and Wilderness Society & University of Northern British Columbia 2018). A poll on climate change action found that the majority of Canadians agreed with the statement that we have moral responsibility to future generations (Abacus Data 2017) and 75% of Canadians believe that protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs (Teel 2022). Almost all Canadians (96%) believe nature is important to their personal well-being, with 57% reporting that it is very important (ECCC 2021c).

This support for nature extends to wildlife species at risk. Most Canadians (88%) indicated it is very or somewhat important to them personally that species at risk are protected across Canada and that protecting natural habitats for wildlife is a priority (91%, this is higher than the option of fighting climate change, 86%) (ECCC 2021c). Almost 90% of Canadians agree that it is important to prevent extinctions (McCune et al. 2017). Although it is challenging to directly compare past surveys on attitudes and values towards wildlife in Canada, historical data shows a consistent trend: a significant majority considered it very or fairly important to maintain abundant wildlife populations (80% in 1981, 83.3% in 1987, and 86.2% in 1991) and to preserve declining populations or endangered wildlife (82% in 1981, 85.2% in 1987, and 83.3% in 1991) (Filion et al. 1987; Gray et al. 1993).

The high level of public support for nature conservation stems from different values (Sandbrook et al. 2019). This diversity of values towards wildlife has been generalized in four general groups 'traditionalists', 'mutualists', 'pluralists', and 'distanced' (Teel 2022) (**Table 4**). The breakdown of these groups in the US. is somewhat different than Canada. Mutualists make up only 35% of the US population, followed by traditionalists (28%). Pluralists (21%) and distanced individuals (15%) comprise a similar proportion of the population in the US and Canada (Manfredo et al. 2018). Mutualism is strongly related to modernization indicators including urbanization, continuing education, and higher income levels. Mutualists are also more likely to agree that protecting endangered species is more important than private property rights (Manfredo et al. 2018; Manfredo et al. 2020). While trends in wildlife orientation have not been researched in Canada, data from the US shows a decline in traditionalists, with an increase in mutualists, pluralists, and distanced individuals.

Table 4: Wildlife orientation values in Canada

Typology/ Definition	%	Regional variation
Traditionalists: This type is characterized by a view of human mastery over wildlife and a prioritization of human well-being over wildlife. Traditionalists believe wildlife should be managed for human benefit	11	Highest percentages in Saskatchewan (18%), Alberta (18%), and Manitoba (17%).
Mutualists: This type views wildlife as capable of relationships of trust with humans. Mutualists believe that humans and wildlife are meant to co-exist or live in harmony, and thus wildlife deserves rights similar to the rights of humans.	50	Highest percentage in Nova Scotia (57%), Quebec (54%), British Columbia (51%), and Ontario (49%).
Pluralists: This type possesses both value orientations. Expression of one or the other orientation is situational.	26	Pluralists are most common in Saskatchewan, New Brunswick, and Ontario (29-31%)
Distanced: This type lacks a well-formed wildlife value orientation, indicating less interest in wildlife-related issues.	14	Highest percentage in British Columbia (16%) and Manitoba (16%). 29% for Canadians identifying as Distanced belonging to a racial or ethnic minority.

Our attitudes around wildlife conservation and endangered species have changed very rapidly over the past 150 years. The myth of superabundance was abandoned by the dawn of the twentieth century (Callicott 1993), and the concept of conservation to both prevent the waste of natural resources (Pinchot 1910) and the intrinsic values of nature (e.g. John Muir (Smith 1998)) have now become largely entrenched in our culture and governance of nature. These attitudes are continuing to evolve. Traditional instrumental values are transitioning to a broader set of values that are based on the intrinsic values of nature (Manfredo et al. 2018). Today, 70–90% of people in western society believe that nature has a right to exist even if it's not useful to humans (Born et al. 2001). In Newfoundland and Labrador, this intrinsic value is included as a guiding principle for in their endangered species legislation, with the recognition that 'all species have the right to exist'. This growing intrinsic valuation of nature combined with an openness to Indigenous worldviews is leading to a growing number of examples where 'Earth Law' has been applied to recognize the rights of nature (O'Donnell et al. 2020) (e.g., the granting the Magpie River in Quebec the right of legal personhood by the Innu Council of Ekuanitshit and the regional municipal council of Minganie, 2021). The KMGBF and Canada's 2030 Biodiversity Strategy both embrace and embody intrinsic valuation of nature with calls for 'a world of living in harmony with nature' and that 'all Canadians have re-established their relationship with and are honouring their responsibilities to nature'.

1.5.7 SPECIES AT RISK AND CANADA'S 2030 NATURE STRATEGY

Canada and other nations that signed the CBD committed to developing 'national strategies, plans or programs for the conservation and sustainable use of biological diversity'. The original CBD did not have explicit targets or measures, but these were later adopted at the tenth meeting of the Conference of the Parties (COP-10), more commonly referred to as the Aichi biodiversity targets (2011-2020). The Aichi biodiversity targets included four goals and 20 targets that provided an overarching framework for implementing the CBD. Parties were to translate this framework into revised and updated national biodiversity strategies and action plans within two years. In 2016 Canada's federal, provincial, and

territorial governments released the 2020 Biodiversity Goals and Targets for Canada in response to the global Aichi Biodiversity Targets (ECCC 2016).

Canada translated the Aichi biodiversity targets into a suite of four goals and nineteen targets. These modified goals and targets purportedly “reflect Canada’s particular context and priorities for biodiversity conservation and articulates the ways in which Canada will contribute to the achievement of the global Aichi Targets.” However, the ambition of several of the global targets was reduced in this national interpretation. For example, the ambitious Aichi target for threatened species conservation (Target 11): *‘By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained’* was attenuated in Canada’s national plan (Target 2) to: *‘By 2020, species that are secure remain secure, and population of species at risk listed under federal law exhibit trends that are consistent with recovery strategies and management plans.’* This target is still measured by Canada and even with its low ambition, has not been met (see **section 1.6.3**).

Canada’s 6th report to the CBD on progress toward meeting the Aichi targets claimed that Canada was on track to meet 11 targets plus the marine and coastal portion of Target 1 (protected areas) and progressing at an insufficient rate to meet six targets plus the terrestrial and inland waters portion of Target 1. Independent assessments found that progress was much lower and that most of Canada’s responses to the Aichi targets were aspirational and not being implemented (Hagerman & Pelai 2016), including a 2018 progress report from Canada’s Environment Commissioner (Office of the Auditor General of Canada 2018). Canada’s Final Report for the 2020 Biodiversity Goals and Targets reported that of the 19 targets, eight had been met, six partially met, one was unclear, and Target 1 on protected areas was split between met (marine) and partially met (terrestrial). Three targets were not met: water pollution, sustainable marine harvests, and threatened species (despite the lower bar in Canada’s target).

Canada is not alone in its failure to meet the Aichi targets. Globally, only six of the 2020 targets have been partially achieved. The other 14, such as eliminating subsidies that are driving biodiversity loss or halving the rate at which natural habitats are being lost, were completely missed (Secretariat of the Convention on Biological Diversity 2020). Several factors contributed to this lack of progress. Most Parties did not set effective national targets, and investments, knowledge and transparent accountability and reporting have been inadequate to enable effective implementation (Xu et al. 2021).

At the 2022 Conference of the Parties (COP 15), Canada was among 196 nations that adopted the Kunming Montreal Global Biodiversity Framework (KMGBF). The framework includes four goals and 23 targets for 2030 and sets an ambitious 2050 mission to halt and reverse biodiversity loss to put nature on a path to recovery. The KMGBF includes a comprehensive suite of goals and targets that include conservation (Goal 1), sustainable use and ecosystem services (Goal 2), equity (Goal 3), and finance (Goal 4). The goals and targets are intended to fully implement the three objectives of the CBD (Section B) and support the Sustainable Development Goals (Section D).

While all goals and targets are interrelated and need to be implemented to achieve the vision of the KMGBF, Goal A is focused on threatened species with the statement *‘Human induced extinction of known threatened species is halted, and, by 2050, the extinction rate and risk of all species are reduced tenfold and the abundance of native wild species is increased to healthy and resilient levels’*. Goal A also includes the other scales of biodiversity with the conservation and restoration of ecosystems and maintenance of genetic diversity.

Target 4 (wildlife conservation and extinction) is to: *‘Ensure urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species, to significantly reduce extinction risk, as well as to maintain and restore*

the genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential, including through in situ and ex situ conservation and sustainable management practices, and effectively manage human-wildlife interactions to minimize human-wildlife conflict for coexistence.’ While this is the cornerstone target for halting and reversing extinction, all targets are connected to Target 4. The recent IUCN The Global Species Action Plan (IUCN 2023a) was developed to support implementation of KMGBF goals and targets on the conservation and sustainable use of species and to show the interconnectedness between targets and species conservation.

The KMGBF also provides a monitoring framework and identifies headline, component, and complementary indicators for each target. Target 4 (threatened species) has a total of 14 headline, component, and complementary indicators (**Table 5**). Canada will have some challenges reporting on the two headline indicators. The IUCN Red List is the authority on globally threatened species, but only about 3,600 species have been assessed that occur in Canada (see **section 1.6.2**), although this number is growing. For the other headline indicator, population size is not known for many species, including species at risk. While 500 individuals is a general guide, based on the 50/500 rule to avoid short-term inbreeding and to preserve long-term adaptive potential (Franklin 1980), it is not directly applicable to many species (Frankham et al. 2014). Effective population size can also vary within the range of a species. For example, a study in Quebec found that viable populations of American Ginseng (*Panax quinquefolius*) contain at least 172 individuals (Nantel et al. 1996) whereas in central Appalachia (United States) viable populations were estimated to have at least 780 to 820 individuals (McGraw & Furedi 2005). Canada has already established indicators on species at risk that will likely continue to form the basis of measurement and reporting on the status and trends of threatened species, although there are opportunities to build in existing habitat indicators (**section 1.6**) and enhance federal reporting on extinctions and recovery (**Chapter 2**).

Table 5: KMGBF indicators for Target 4 (threatened species)

Headline indicators (Indicators which are intended to capture the overall scope of a goal or target. They are nationally, regionally and globally relevant indicators validated by Parties.)
A.3 Red list Index
A.4 The proportion of populations within species with an effective population size > 500
Component indicators (Optional indicators that together with the headline indicators cover all components of the goals and targets of the KMGBF which may apply at the global, regional, national and subnational levels.)
Living Planet Index
Number of plant and animal genetic resources secured in medium- or long-term conservation facilities
Trends in effective and sustainable management of human-wildlife conflict and coexistence
Green Status of Species Index
Conservation status of species listed in the CITES Appendices has stabilized or improved
Complementary indicators (Optional indicators for thematic or in-depth analysis of each goal and target which may be applicable at global, regional, national, and subnational levels.)
Species threat abatement and restoration metric
Changing status of evolutionary distinct and globally endangered species (EDGE Index)
Percentage of threatened species that are improving in status
Number of CMS daughter agreements
Proportion of local breeds classified as being at risk of extinction
Red List Index (wild relatives of domesticated animals)
Rate of invasive alien species establishment

Unlike Canada's 2020 Biodiversity Goals and Targets that took five years after release of the Aichi Biodiversity Targets, the national biodiversity strategy to implement the KMGBF was released in 2024 (ECCC 2024a). Also, unlike Canada's previous domestic implementation strategy, Canada's 2030 Nature Strategy has adopted all the goals and targets for the global framework and has committed to an ambitious strategy to halt and reverse the loss of nature. However, the ability of the federal government to coordinate action within the federation and among other actors remains to be seen. Actions in the strategy focus on current federal initiatives, followed by a 'going further' section that highlights new commitments and potential actions. Provincial and territorial contributions are included but are very inconsistent and generally focus on past and current actions. For Target 4 (species recovery) current federal initiatives include Indigenous partnerships, continued implementation of SARA and funding programs, and strengthening collaborations, including Nature Agreements. New actions to advance Target 4 are: exploring approaches to improve the efficiency and transparency of SARA, accelerating listing of aquatic species assessed as endangered or threatened, and increased knowledge sharing. Potential opportunities include a new data platform to support recovery reporting and information sharing and multi-species stewardship approaches.

1.6 THE STATUS AND TRENDS OF SPECIES AT RISK IN CANADA

One of the fundamental questions in conservation is deciding which species should be the focus of recovery actions. Understanding the approaches, data, and actors that drive to extinction risk decision-making, is essential to contextualize the status and trends of species at risk in Canada. Quantifying the status and trends of species at risk and their habitat is crucial for informing the public, conservation practitioners, and decision-makers, yet presents many challenges.

1.6.1 DECIDING WHICH SPECIES ARE AT RISK

Wild species do not come with labels. Decisions on taxonomy, status, and funding for conservation, while 'science-based', occur within a broader framework of human values and culture. Traditional wildlife conservation was largely based on instrumental values. As explored in **section 1.4**, the first conservation laws aimed to maintain hunting opportunities (Foster 1998; Matthiessen 1959). While conserving the full diversity of life now has greater recognition and there is a growing trend to value nature for intrinsic reasons in Western society, our conservation decisions have biases. Whether for instrumental or intrinsic purposes, our affinity for wildlife displays a bias between different species. Many conservation efforts and public campaigns focus on charismatic species (Clark & May 2002). People also tend to value rare species over common ones (Angulo & Courchamp 2009). The value placed on rarity, whether a panda or gold, may be explained by the theory of scarcity value, where lower supply increases demand (Smith 1887). This exaggerated value on scarce wildlife is evident in bird-watchers flocking to see a rare species or in hunting for exceptional specimens (Courchamp et al. 2006).

Today, there are many approaches that assess extinction risk. These include CITES (see **section 1.5.1**) (Reeve 2014), EDGE of Existence Programme (Isaac et al. 2007), Partners in Flight (North American Bird Conservation Initiative 2016; Partners in Flight 2017), Alliance for Zero Extinction (Parr et al. 2009), and Fishbase (Strona 2014). However, there are three primary institutions that prioritize and assess the conservation status of wild species in Canada: International Union for Conservation of Nature (IUCN), Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and NatureServe (**Table 6**).

The IUCN was established in 1948 as the first global organization dedicated to protecting nature. Although the IUCN began gathering information on rare and declining wildlife species in the 1950s, its

first comprehensive list was published in 1965 (Scott 1965; Vié et al. 2009). This initial list included 516 species, categorized based on rarity and trends. The IUCN developed the first categories and criteria to assess global extinction risk and has continually updated these tools (IUCN Standards and Petitions Subcommittee 2019).

COSEWIC was established in 1977 as Canada's first national organization for identifying wildlife threatened with extinction. COSEWIC was incorporated into the *Species at Risk Act* (SARA) when the legislation was introduced, serving as the formal scientific body to assess extinction risk. COSEWIC assessments are generally more detailed than IUCN Red List assessments and NatureServe rankings, using a modified IUCN Red List process to evaluate extinction risk.

NatureServe, a network of over 80 Conservation Data Centres across North and South America, including all Canadian provinces and territories, was established in 1994. It assesses the global, national, and sub-national (provincial/territorial) status of species and infraspecies based on standardized criteria including rarity, trends, and threats (Master et al. 2012). NatureServe programs in Canada rank species across a wide range of taxa, including many not assessed by the IUCN or COSEWIC. The NatureServe system has ranked the status of almost 30,000 species in Canada and updates national status rankings every five years to support federal reporting on the general status of species (CESCC 2016, 2022)

There are several key differences in the assessment categories used by these institutions. COSEWIC assessments combine the IUCN critically endangered and endangered categories into "endangered," and use "threatened" in place of the IUCN's vulnerable category. NatureServe uses a different system from the IUCN Red List (Master et al. 2012), which is less detailed but has similar thresholds. Despite the differences in the risk categories used by these three institutions, there are many similarities in the hierarchy of extinction risk (**Table 7**).

It is important to highlight the definition of "wildlife species" under SARA. According to SARA, "wildlife species" includes subspecies, varieties, or geographically or genetically distinct populations. Guided by this definition, COSEWIC assesses extinction risk not only for species but also for units below the species level that are considered discrete and evolutionarily significant. These units, referred to as "designatable units" (DUs) by COSEWIC, are evaluated for discreteness and significance according to specific guidelines (COSEWIC 2018). DUs are eligible for legal listing and management under SARA as "wildlife species." COSEWIC refers to DUs as "populations," a term that can differ from its biological meaning¹. COSEWIC also identifies and assesses subspecies as DUs, such as the Gray-cheeked Thrush minimus subspecies (*Catharus minimus minimus*). In practice, a full species (e.g., Copper Redhorse [*Moxostoma hubbsi*]) receives the same level of protection under SARA as a DU or population (e.g., Channel Darter [*Percina copelandi*] – Lake Ontario populations). COSEWIC's DUs are similar to the units used in the US under the *Endangered Species Act* called "Distinct Population Segments." For example, the US also uses the concept of 'evolutionarily significant units' to define Distinct Population Segments for the assessment of Pacific salmon species.

Infraspecies are ranked by NatureServe, and while NatureServe does not identify DUs, it will rank DUs identified and assessed by COSEWIC. Assigning global ranks to DUs is very problematic for NatureServe because COSEWIC Species Specialist Committees are inconsistent in identifying the DU range outside of

¹ A population is often defined as a group of individuals of the same species living in the same geographical area at the same time. IUCN refers to units below the species level of classification as 'sub-populations', while COSEWIC uses 'population'. This is because under SARA a DU is considered a 'wildlife species'. The population of the DU represents the population of the 'wildlife species'.

Canada¹. The IUCN Red List has not focused on assessments of infraspecies (Norderhaug et al. 2024), though some have been conducted for specific taxa in Canada, such as the Lake Sturgeon (*Acipenser fulvescens*) in the Churchill River watershed subpopulation. However, the approaches to identifying subpopulations by the IUCN and DUs by COSEWIC are different. While IUCN may consider threats and management, COSEWIC focusses on discreteness and evolutionary significance.

Table 6: How wildlife extinction risk is assessed in Canada

	IUCN	COSEWIC	NatureServe
Scope	Global	National	Global, national & subnational
Taxonomical Units assessed	Species, some subpopulations	Species, designatable units	Species and infraspecies
Risk Categories	Extinct Extinct in the wild Critically endangered Endangered Vulnerable Near threatened Least concern Data deficient Not evaluated	Extinct Extirpated Endangered Threatened Special Concern Data Deficient Not At Risk	Presumed Extinct Possibly Extinct Critically Imperiled Imperiled Vulnerable Apparently Secure Secure Unrankable Unranked
Criteria	A. Declining population (past, present and/or projected) B. Geographic range size, and fragmentation, decline or fluctuations C. Small population size and fragmentation, decline, or fluctuations D. Very small population or very restricted distribution E. Quantitative analysis of extinction risk (e.g., Population Viability Analysis)	A. Decline in Total Number of Mature Individuals B. Small Distribution Range and Decline or Fluctuation C. Small and Declining Number of Mature Individuals D. Very Small or Restricted Total Canadian Population E. Quantitative Analysis	• Range Extent • Area of Occupancy • Population • Number of Occurrences • Number of Occurrences or Percent Area with Good Viability • Environmental Specificity • Long-term Trend • Short-term Trend • Threats • Intrinsic Vulnerability
Who prepares assessments?	Experts in Species Specialist Committees	Most are prepared by external consultants though an RFP process	Conservation Data Centres in consultation with experts
Application	IUCN Red List is used by many countries and international organizations to set priorities and for environmental assessment.	Species assessments are reviewed by government, and socio-economic impacts are considered. Species may then be listed under SARA.	Used for comprehensive reporting on species status and status trends (CESC 2022). Also to set priorities for COSEWIC.
Other Notes	Some species identified as occurring in Canada are very peripheral or accidental (e.g., Bermuda Petrel).		

¹ For example, the mollusc Species Specialist Committee (SSC) identifies DU range outside of Canada, while the freshwater fishes SSC does not. This also creates a barrier to potential future reintroductions.

Table 7: Comparison of extinction risk categories used by IUCN, COSEWIC & NatureServe

IUCN Red List	COSEWIC	NatureServe	Notes
Extinct	Extinct	Extinct	
NA	NA	Possibly Extinct	The Red List may tag Critically Endangered species as Possibly Extinct or Possibly Extinct in the Wild
Extinct in the Wild	NA	NA	
NA	Extirpated	Extirpated*	*Applies to national and subnational ranks only
Critically Endangered	Endangered	Critically Imperiled	Critically Endangered: extremely high risk of extinction
Endangered			Endangered: very high risk of extinction
Vulnerable	Threatened	Imperiled	
Near Threatened	Special Concern	Vulnerable	Past COSEWIC assessments have used 'rare' and 'vulnerable' for this category. A 'watch-list' category. Species are likely to move up to higher risk category unless causes of decline are addressed.
Least Concern	Not at Risk	Apparently Secure	Apparently Secure: fairly low risk of extinction
		Secure	Secure: very low risk of extinction
Data Deficient	Data Deficient	Unrankable	
Not Evaluated	NA	Unranked	

1.6.2 CURRENT NUMBERS OF SPECIES AT RISK IN CANADA

The different approaches and criteria used by IUCN Red List, COSEWIC, and NatureServe result in different numbers of species that are assessed as at risk of extinction¹. The number of species at risk in Canada, or any location, is also both uncertain and dynamic. Numbers change in response to new information on both the risk of extinction and our growing knowledge of species. The numbers below provide a snapshot of Canada species that have been assessed at risk of global or national extinction.

IUCN Red List

The IUCN Red List of Threatened Species has assessed 3,607 species (includes subspecies and varieties, and subpopulations) that occur in Canada, excluding introduced, vagrant, and species with uncertain origin/presence (IUCN 2023b). This includes 339 species from Canada that are assessed as critically endangered (31), endangered (73), vulnerable (124), and near threatened (111).

COSEWIC

COSEWIC has assessed 875 species as Extinct (25), Extirpated (21), Endangered (373), Threatened (199), or of Special Concern (258). These species occur in all provinces and territories, with the highest numbers in British Columbia, Ontario, and Quebec. Since SARA's enactment in 2002, the number of species assessed as at risk by COSEWIC has increased by nearly 4% annually. Currently, 187 species (21% of eligible species) assessed as at risk by COSEWIC are not listed under SARA. COSEWIC focuses on the

¹ These numbers were updated in December 2023 after Chapters 3 and 4 were published. As a result, the numbers presented below will differ in subsequent chapters.

national status of wild species, though global status and jurisdictional responsibility is considered in prioritizing species for assessment (see **Chapter 3**). About one-third of COSEWIC-assessed species are also of global conservation concern based on NatureServe global ranks (NatureServe 2023).

NatureServe

NatureServe has identified 1,540 species of global conservation concern in Canada, ranked as critically imperiled, imperiled, or vulnerable. This includes subspecies, varieties, populations, and species with provisional taxonomy. The provinces with the greatest number of these species are British Columbia, Quebec, Ontario, and Alberta. Currently, approximately 16% of these species are listed under SARA (NatureServe 2023).

Canada's general status report on wild species, based on national NatureServe ranks, focusses on taxa at the species level. Among ranked species, 20% face some level of risk in Canada. This national assessment highlights that 873 species are critically imperiled, 1,245 are imperiled, 2,765 are vulnerable, 9,562 are apparently secure, and 10,038 are secure. Furthermore, 40 species are presumed extirpated and 95 are possibly extirpated, suggesting they have likely disappeared from Canada.

This accounting of species at risk in Canada by IUCN, COSEWIC, and NatureServe highlights the 'assessment gap' facing the protection and recovery of species at risk under SARA. Only a small fraction of species of global and national conservation concern have been assessed by COSEWIC. Additionally, there are at least 21,000 known species for which we lack basic information on their range, habitat, and population, and another 30,000 species that are poorly described or unknown (excluding viruses and bacteria, and infraspecies) (CESCC 2022).

Extrapolating from the risk of identified in the most recent general status report (i.e., one in five of assessed species are at some level of risk) (CESCC 2022), there may be over 15,000 species of conservation concern in Canada¹. These are species that, if assessed using NatureServe criteria, are likely to be ranked as critically imperiled, imperiled, or vulnerable. Canada may therefore have over 30 times more species of national conservation concern than are officially recognized under SARA. This may be a conservative estimate given that poorly documented species tend to be at a higher risk of extinction (Borgelt et al. 2022; Liu et al. 2022; Régnier et al. 2015) and that co-extinctions are likely to increase in a future of climate changes and continued habitat loss (Strona & Bradshaw 2022).

1.6.3 TRENDS OF SPECIES AT RISK AND THEIR HABITATS

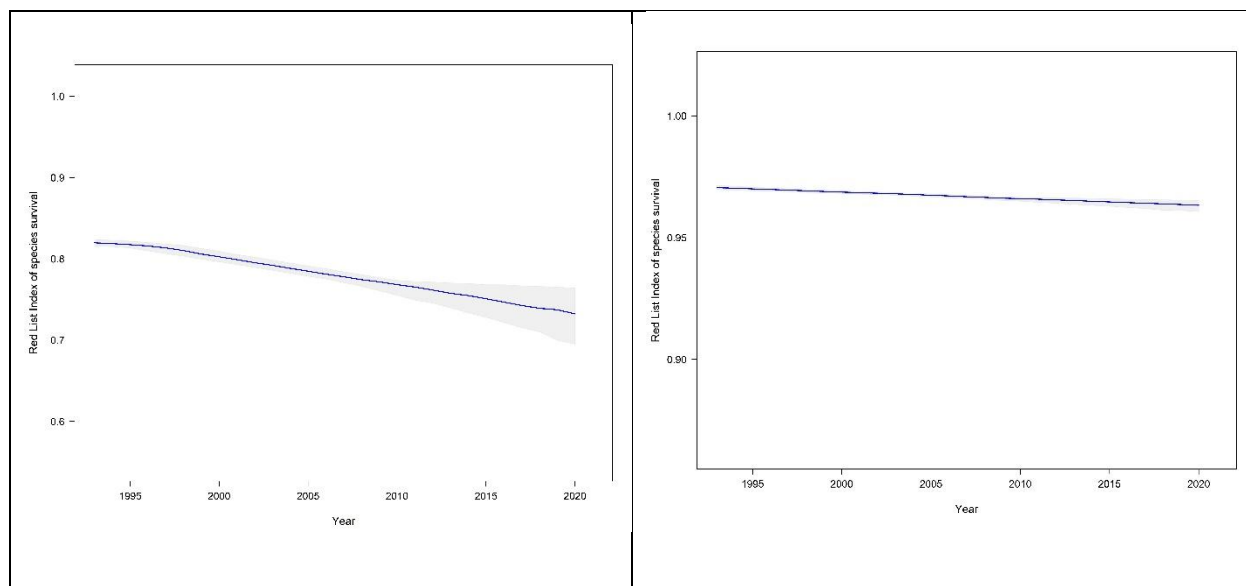
While there is uncertainty in the numbers of species at risk, trends provide a better understanding of the current status of wildlife species, encompassing both improvements and declines. This section explores trends in wildlife and habitats based on key global and national data and reporting. Many other approaches exist for reporting on wildlife trends, including regional trends assessments, which are not included in this review (e.g., Environment and Climate Change Canada & U.S. Environmental Protection Agency 2021; Ontario Biodiversity Council 2020).

Globally the IUCN **Red List Index** (RLI) offers a comprehensive measure of extinction risk (Butchart et al. 2007; Butchart et al. 2006). The RLI synthesizes data from the IUCN Red List and provides a quantitative measure of changes in global extinction risk over time, reflecting improvements or deteriorations in species' conservation statuses. It considers only 'genuine changes' in the number of species in each extinction risk category (see **Chapter 2**). The RLI can be disaggregated for subsets of species and to produce national Red List Indices. However, the RLI has limitations, particularly in the Canadian context.

¹ 80,000 wild species (6.8% subtracted for non-native species).

This is due to the paucity of Red List assessments for Canadian species and a bias towards birds and mammals because of longer term data sets. This bias results in an RLI for Canada that is relatively flat compared to the global trend (**Figure 1**). Additionally, the RLI may not adequately represent regional variations, as global trends might mask localized threats. Despite these limitations, the RLI is an emerging tool to track trends of threatened species and serves as a headline indicator for Target 4 of the KMGBF.

Figure 1: Red List Index, global & Canada



Global: Index values are based on data from mammals (5701), birds (11117), amphibians (6681), corals (842), cycads (304).

Canada: Index values are based on data from mammals (206), birds (470), amphibians (51). See text for limitations on applying Red List Index in Canada.

Generated from <https://www.iucnredlist.org/search> (April 13, 2024)
Grey shading depicts confidence levels (95%).

While the RLI can provide some trends of globally threatened species and used to compare Canada to other nations, the primary reporting for wildlife trends in Canada comes from federal environmental sustainability indicators.

The **Canadian species index** (ECCC 2023d) employs methodologies similar to the Living Planet Index (explored later in this section), focusing on 928 monitored species of birds, fish, mammals, amphibians, and reptiles to identify population abundance trends since 1970. Unlike measuring the absolute change in the total number of animals, this index calculates an "average of trends," where each species, regardless of its commonality or rarity, contributes equally to the overall assessment. From 1970 to 2018, the indicator shows a 7% average decline in the population abundance of all monitored vertebrate species, an improvement from a previous analysis showing a 10% decline between 1970 and 2014 (Marconi et al. 2021). Declines are greater for some groups, with monitored mammal and fish species experiencing 42% and 30% average declines, respectively. This index is limited to vertebrates and currently represents 52% of the 1,798 native vertebrate species that regularly occur in Canada.

The Canadian species index also tracks trends in major ecosystems by categorizing species into terrestrial (most birds and mammals, some reptiles and amphibians), freshwater (fishes, waterfowl, waterbirds, most amphibians and reptiles, some mammals), or marine (marine birds, mammals, fishes) systems. From 1970 to 2018, the index for the terrestrial system decreased by 14%, and for the marine system by 16%, while the index for the freshwater system increased by 38%. This optimistic assessment of freshwater systems may be driven by a ‘bird bias,’ as a more detailed assessment of all freshwater species of plants and animals found 11.7% to be at risk (Desforges et al. 2021) and globally there has been an 83% decline in the relative abundance of populations of freshwater species since 1970 (WWF 2022).

The **general status of wild species** (ECCC 2023b) indicator, based on the Wild Species 2020 report, encompasses 50,534 species, with approximately half (24,483) assigned a NatureServe rank. Between the previous report (2015) and 2020, a total of 8,107 species experienced shifts in their conservation status rank at the national level. This included 1,199 species facing a heightened extinction risk and 1,186 species experiencing reduced extinction risk. Similar to the RLI, the general status report identifies genuine and non-genuine changes in status, although there are many gaps. Of the 8,107 changes in conservation status between 2015-2020, only 92 are reported as genuine. This includes six species with a decline in extinction risk due to increases in population size or distribution. Conversely, 18 species encountered heightened risk due to modifications in population size, distribution, or threats. The remainder comprised new species added to the report.

However, the reported number of species from diverse taxonomic groups, including birds (46), mammals (14), reptiles (6), amphibians (4), fishes (46), and vascular plants (84), experiencing increased extinction risk suggests that the number of genuine status changes might be incomplete. As discussed in **Chapter 2**, implementing a more systematic approach to differentiate genuine status changes from other changes is crucial for effectively monitoring trends and guiding conservation efforts.

The indicator on **species at risk population trends** (ECCC 2023c) is directly related to SARA and tracks whether the population and distribution trends of species at risk are consistent with the objectives set out in final recovery strategies or management plans. Of the 158 species at risk that include population and distribution objectives and for which trends could be determined, as of May 2023: 44% showed progress towards their objectives, 44% do not show progress towards their objectives, and 12% showed mixed evidence with some information suggests improving trends, but there is also some evidence of decline. Fishes, mammals, and vascular plants show the most progress, while reptile and amphibian species show no progress. Progress also varies by risk categories. Of the 33 species of special concern, 67% show progress towards their population and distribution management objectives, but of the 121 extirpated, endangered and threatened species only 36% show progress.

Current reporting suggests a worsening trend when compared to the 2018 Auditor General Report (Office of the Auditor General of Canada 2018), which revealed that in 2014, the objectives outlined in the recovery strategies and management plans were unmet for 32% of species at risk (30 out of 94 species), and in 2016, this figure increased to 37% (46 out of 123 species). In the audit, ECCC acknowledged that species recovery is a time-intensive process and emphasized that a two-year timeframe was insufficient to assess the effectiveness of recovery actions for most species. This is an important response; it can take decades for several generations of a population to show progress towards objectives and respond to management and recovery actions. Time is also needed to collect and assess information to demonstrate progress.

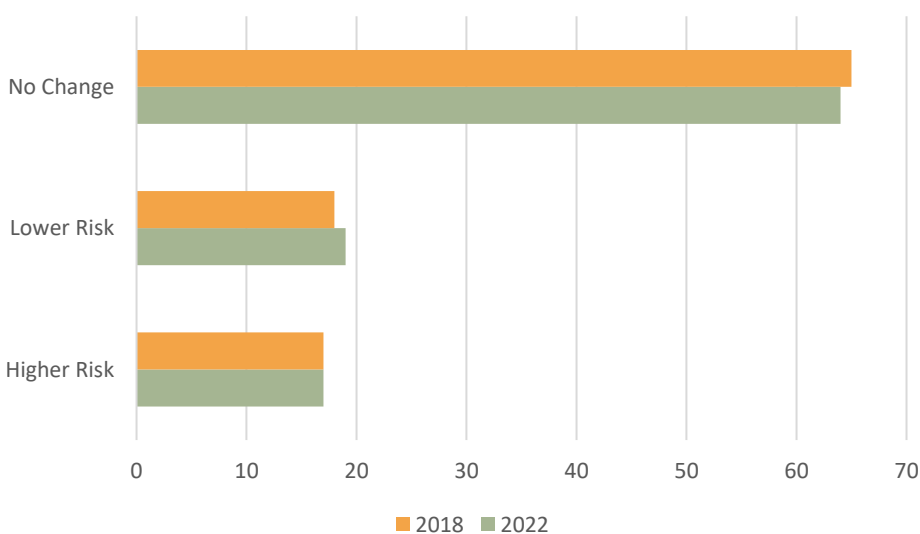
The ECCC response and the reported progress of almost two-thirds of special concern species in meeting recovery document objectives are notable. While special concern species often have less immediate threats (hence their assessment as special concern), this progress is likely the result of non-genuine

recovery and is explored in detail in **Chapter 2**. Recovery documents in Canada have also been criticized for their lack of ambition (Pawluk et al. 2019). However, lowered ambition for population and distribution management objectives, and as demonstrated in the next indicator, do not always translate into reduced risk. For example, this indicator on species at risk population trends reports that no amphibians show progress, but the status of the Rocky Mountain Tailed Frog (*Ascaphus montanus*) was downlisted from endangered to threatened in 2013. Black-tailed Prairie Dog (*Cynomys ludovicianus*) is meeting its population and distribution management objectives but was uplisted from special concern to threatened in 2018.

Changes in the status of wildlife species at risk (ECCC 2023a) reports on changes in the status of wildlife species at risk when they are reassessed by COSEWIC (approximately every 10 years). Of the 535 wildlife species at risk that have been reassessed, and for which sufficient data is available to determine if there has been a change in status: 16% are now in a higher risk category; 20% are now in a lower risk category, and 64% show no change in status. These recent results are similar to the 2018 report on this indicator (**Figure 2**).

There have been some improvements in this indicator in the last decade (Favaro et al. 2014). At that time, of the 369 species that had then been reassessed: 31% were in a higher risk category, 14% were in a lower risk category, and 55% showed no change in status. Unlike the IUCN Red List or general status report, there is no differentiation between genuine and non-genuine status changes. This is explored in greater depth in **Chapter 2**. Another limitation of this indicator is that many species are not reassessed on a regular schedule and species previously assessed by COSEWIC that are facing new threats are more likely to be prioritized for assessment (C. Whelan, ECCC, pers comm, September 24, 2024).

Figure 2: Changes in the status of species at risk (percent)



This indicator reports on changes in the status of wildlife species at risk when they are reassessed. Species are reassessed when sufficient data becomes available to determine whether there was a change in status. Since 1978, 535 species have been reassessed.

The final federal environmental sustainability indicator on wildlife trends is on **trends in Canada's bird populations** (ECCC 2019e). Although limited to a single taxon, birds benefit from the most comprehensive and well-established monitoring programs. Drawing on data from various monitoring initiatives to survey different bird species and habitats, the indicator provides the most reliable estimate of population trends across native bird species in Canada. Results from 1970-2016 reveal a 150% increase in waterfowl populations and a 110% increase in birds of prey. However, several bird groups experienced declines, including shorebirds (-40%), grassland birds (-57%), and aerial insectivores (-59%). Conversely, wetland birds, seabirds, forest birds, and other avian species exhibited little to moderate change. These findings informed the development of Canada's 2019 State of Birds report (NABCI 2019) and contribute to another federal environmental sustainability indicator concerning the population status of Canada's migratory birds (not further explored in this chapter).

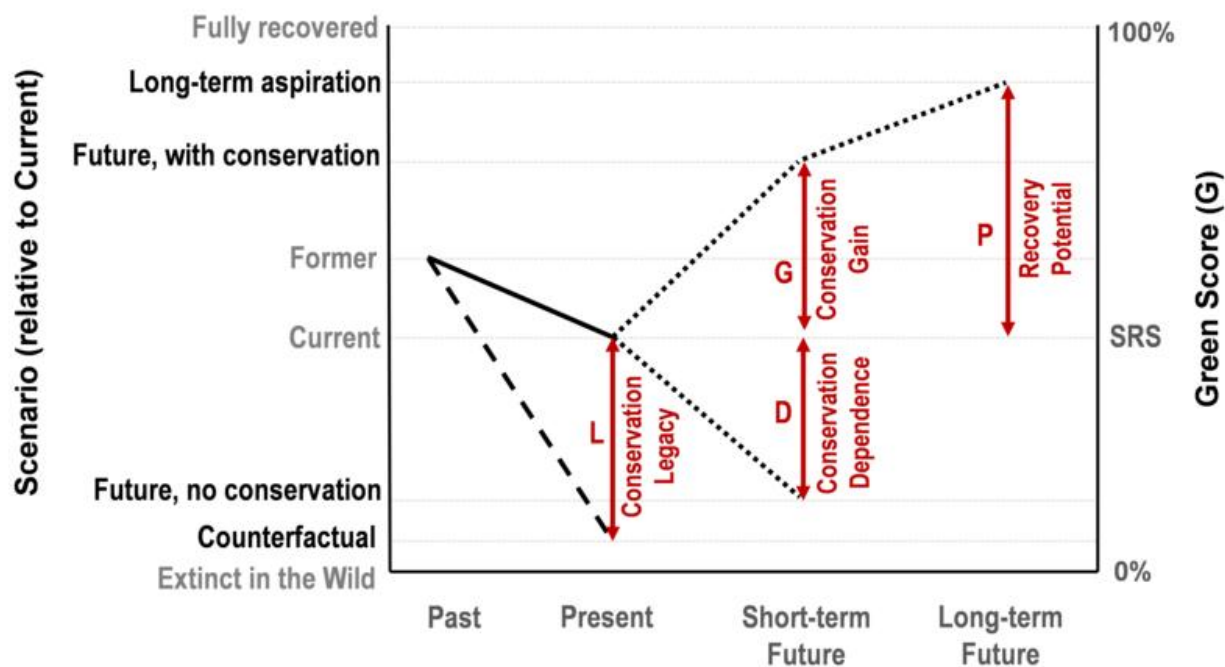
In addition to the federal indicators on wildlife trends, World Wildlife Fund Canada's **Living Planet Report for Canada** (WWF-Canada 2020). (WWF 2022) uses the Living Planet Index (LPI). While similar to the federal Canadian species index, it does offer some different results. The report highlights that populations of 883 native vertebrate species exhibited an average near-stable trend of 6% from 1970 to 2016. However, this positive trend is an average and not applicable across all groups. The analysis found that populations of Canadian species assessed as at risk declined by 59%, and those assessed as globally at risk (classified as threatened on the IUCN Red List) experienced an average decline of 42%.

The LPI (along with the Canadian species index) have several key limitations (McRae et al. 2025). The index is biased towards managed species, species that are easier to observe, and species with aesthetic appeal, and baseline abundance levels (1970) may be low compared to historic abundance. Long-term studies on species population also tend to be bias towards declining species (Fournier et al. 2019). The results are also influenced by data quality and gaps in taxonomic and geographic coverage (Collen et al. 2009; Marconi et al. 2021). A more complete assessment of the variability in population change trends, with particular attention to covarying populations, would enrich the LPI's influence on conservation (Hébert & Gravel 2023).

The **IUCN Green List** is a new tool designed to monitor and report on wildlife trends. While extinction and extinction risk are well-defined, the concept of recovery and conservation success remains vague and lacks common metrics (Akçakaya et al. 2018). The current global initiatives to develop 'Green Lists' of species aim to better define and quantify species recovery (Akçakaya et al. 2018; Akçakaya et al. 2020; Grace et al. 2021). The Green List can be used to assess recovery needs, set priorities, and identify opportunities for maximizing the benefits of investment in recovery efforts (Akçakaya et al. 2018). It is envisioned to create metrics that elucidate the anatomy of successful species recovery and the barriers to progress. In the context of SARA, the Green List could provide a useful benchmark for comparing recovery strategies and management plans, and for identifying the expected recovery progress if recovery actions are implemented.

As a test case, the Lake Erie Watersnake (*Nerodia sipedon insularum*) (global population) demonstrates the benefits of past conservation efforts, highlighting estimated losses without conservation, current conservation dependence, expected conservation gains from future actions, and long-term recovery potential (**Figure 3**). Without past and existing conservation actions, the Lake Erie Watersnake would likely be assessed as vulnerable or endangered on the Red List, rather than its current assessment of 'conservation dependent' using the Green List approach.

Figure 3: Green List metrics



The four conservation metrics assessed for the Green Status of Species. The Green Score (G) (right y-axis) is estimated at each of the bolded scenarios on the left y-axis. Contextual reference points are also provided on the left y-axis. The differences between the Green Score generated under a scenario and the current Green Score (i.e., the Species Recovery Score, labelled SRS) produce the four Conservation Metrics (red arrows and text). Figure adapted from Akçakaya et al. (2018).

In addition to indices that monitor and report on wildlife populations, assessing the status and trends of wildlife habitats is crucial for understanding the scope and magnitude of this primary driver of species loss in Canada. The most comprehensive assessment of the status of ecosystems was completed in 2010 (Federal Provincial and Territorial Governments of Canada 2010). This report documented that all biomes are impaired to some extent, with grasslands and ice being particularly affected. Most biomes are in decline, except for forests, which have a stable overall area but exhibit changes in structure, such as the loss of old-growth forests. Additionally, the report noted the recovery of many marine mammals (Table 8).

Table 8: Status & trends of major biomes in Canada

Biome	Findings from 2010 Ecosystem Status and Trends Report
Forests	• The extent of forests has changed little since 1990 at the national level. • At a regional level, loss of forest extent is significant in some places, but there have also been increases in forest cover in some regions including southern Ontario. • Forests have generally become increasingly fragmented with less old growth. Tree diversity has also been reduced by invasive species and selective forestry practices.
Grasslands	• Native grasslands have been reduced to a fraction of their original extent and continue to decline. • The health of many existing grasslands has also been compromised by a variety of stressors.
Wetlands	• High loss of wetlands has occurred in southern Canada. • Loss and degradation continue due to a wide range of stressors
Lakes and rivers	• Trends over the past 40 years influencing biodiversity in lakes and rivers include seasonal changes in magnitude of stream flows, increases in river and lake temperatures, decreases in lake levels, and habitat loss and fragmentation.
Coastal	• Coastal ecosystems are believed to be healthy in less developed coastal areas, although there are exceptions. • In developed areas, the extent and quality of coastal ecosystems are declining because of habitat modification, erosion, and sea-level rise.
Marine	• The changes observed in marine biodiversity over the past 50 years have been driven by a combination of physical factors and human activities, such as oceanographic and climate variability, and overexploitation. • While certain marine mammals have recovered from past overharvesting, many commercial fisheries have not.
Ice	• Declining extent and thickness of sea ice, warming and thawing of permafrost, accelerating loss of glacier mass, and shortening of lake-ice seasons are detected. • Impacts, apparent now in some areas and likely to spread, include effects on species and food webs.

Some habitat trends continue to be monitored through the federal environmental sustainability indicators, although these are very incomplete. Current indicators include changes in land use and wildlife habitat capacity. The federal **land-use change** indicator measures the amount of land-use changes from 2010 to 2015 in Canada's provinces (i.e., territories not included) (ECCC 2021b). One of the largest changes was the conversion of 2,258 km² of forest to cropland and 745 km² of forest to settlement. These conversions were greatest in Ontario, Quebec, and the Prairie region. This indicator does not measure loss of grasslands and wetlands. However, regional assessments in southern Canada show these biomes also continue to be lost. For example, southern Ontario lost over 134 km² of wetland between 2000 and 2015 (Ontario Biodiversity Council 2020).

The challenge of habitat loss is exacerbated in southern Canada because the quality and extent of wildlife habitat on agricultural lands is declining. **Wildlife habitat capacity on agricultural land** decreased by 5% across Canada between 1981 and 2001 (Javorek et al. 2007) and by 13.9% between 1996 to 2011 (Clearwater et al. 2016). While the overall capacity was stable between 2011 to 2017, there were significant regional variation (ECCC 2019a). Wildlife habitat capacity in the western Prairies increased with a shift in from grain to pastures and hay. Wildlife habitat capacity in the eastern Prairies

declined through conversion of pastures and hay to annual crops such as soybeans, grains, and oilseeds. There was also a decline in eastern Canada, particularly in the St. Lawrence Lowlands. This decline is associated with an expansion of agricultural fields resulting in the loss of natural cover, and is exacerbated by the agricultural intensification which converts pasture and forage into row crops (Fyson et al. 2024)

While agricultural lands occupy only about 6.2% of Canada (Agriculture and Agri-Food Canada 2023), and settlements just over 0.2% (Wang 2018), one of the key habitat challenges for wildlife conservation is that most of Canada's species at risk are found in the regions where habitat loss has been greatest and continues to occur (Kraus & Hebb 2020). Interestingly, Canada reports on the wildlife capacity of agricultural lands, yet there is no equivalent reporting on the wildlife capacity in industrial forests. Forest degradation, defined as the reduction or loss of biological complexity, results from harvest practices and intensive silviculture. In eastern Canada, forest degradation led to the loss of breeding habitat for 66% of the 54 most common species from 1985 to 2020, primarily due to a reduction in old-age classes (Betts et al. 2022).

1.6.4 THREATS TO SPECIES AT RISK

Habitat indicators are critical for endangered species conservation. Globally, habitat loss has been identified as the most significant driver of biodiversity decline (Díaz et al. 2019; IPBES 2019). However, while habitat loss is the main contemporary driver, overexploitation and invasive species are the primary drivers of global species extinctions since 1500 (Bellard et al. 2016). Climate change is predicted to be a major cause of species extinctions in the next century, with recent estimates forecasting the climate-related extinction of 14%-32% of species in the next ~50 years, potentially including 3-6 million (or more) animal and plant species, even under intermediate climate change scenarios (Wiens & Zelinka 2024).

In Canada, key threats to species at risk include habitat loss due to agriculture and urban expansion, overexploitation, invasive species, and interactions with native species (Prugh et al. 2010; Venter et al. 2006; Woo-Durand et al. 2020). Human disturbance and invasive species are the most frequently listed threats in species recovery strategies (McCune et al. 2013). While overexploitation is a driver of global extinctions, it is less significant in Canada except for certain marine fishes and species collected for pets of medicinal properties. The threats of climate change and pollution are increasingly being identified as threats to species at risk (Woo-Durand et al. 2020). One of the current challenges in species recovery is the high number of threats and their cumulative impact. Species at risk in Canada face an average of 5.06 (± 2.77) threats listed in COSEWIC assessments (Currie & Marconi 2020).

There is no shortage of facts and figures on the status and trends of wildlife in Canada. However, one of the challenges of the biodiversity crisis is the lack of a single definitive measure to track progress. Unlike climate change, which can be monitored by the amount of carbon dioxide in the atmosphere, there is no single measure for the health of wildlife and ecosystems due to their complexity. Multiple coordinated goals will be required to understand and track progress in biodiversity conservation (Díaz et al. 2020).

However, the status and trends of Canada's wildlife convey two key messages. First, wild species and their habitats continue to decline in Canada. Second, there is a more hopeful message: certain groups of species, such as waterfowl and raptors, along with a small group of species at risk, have shown improvements in conservation status. This demonstrates that despite the complexity of wildlife recovery, effective solutions do exist. The fundamental question is whether we can simultaneously address the key threats causing wildlife declines and accelerate recovery efforts.

1.7 CAN WE HALT AND REVERSE THE LOSS OF WILDLIFE?

Wildlife conservation is a complex social-ecological problem where outcomes fail to meet intention. As explored in this chapter, there are many enabling factors to support conservation. Canada has agreements and legislation to protect endangered species. Government, philanthropic organizations, and civil societies invest hundreds of millions of dollars annually in nature conservation (Statistics Canada 2018b). Public support for endangered species laws and conservation is strong (Bruskotter et al. 2018; McCune et al. 2017; Rudd 2009), and values are shifting towards an appreciation of the intrinsic values of nature (Born et al. 2001; Manfredo et al. 2020). There is evidence that conservation actions are effective (Langhammer et al. 2024) and spending can slow some biodiversity declines (Waldron et al. 2017).

However, despite these enabling factors, current conditions have not been sufficient to halt and reverse the loss of biodiversity. Very few species are being recovered in Canada, more continue to decline, and new approaches are needed to halt and reverse the loss of wildlife. The call of the KMGBF and Canada's 2030 Nature Strategy to halt and reverse the loss of nature will require solutions from both science and society.

The remainder of my thesis seeks to address the broader question of how to halt and reverse the decline of wild species through three research objectives. My research objectives are first focused on filling in knowledge gaps on species loss and recovery, and identifying species where Canada has full conservation jurisdiction. I will then explore barriers and opportunities through the lens of both policy and practice. The concluding chapter summarizes and offers suggestions for transforming species at risk recovery in Canada.

Research objective 1: Identify the patterns and processes of wildlife extinction and recovery in Canada, with a detailed examination of nationally endemic species.

Chapter 2: Patterns of species loss and recovery in Canada

This foundational chapter identifies the patterns and processes of wildlife extinction and recovery in Canada. It presents the results of a novel analysis on the number, taxa, locations and driving factors of species that have been lost and recovered in Canada and identifies some of lessons of wildlife loss and recovery that can be applied for new approaches.

Chapter 3: Prioritizing nationally endemic species for conservation

Chapter 3 builds on the previous chapter in creating a novel dataset to both provide a baseline and to better inform conservation decision-making for species where Canada has full conservation responsibility. This analysis created Canada's first list of nationally endemic species, identified spatial hotspots where they occur, and provides recommendations for their conservation.

Research objective 2: Compare and examine the effectiveness of national endangered species assessment, listing and recovery, thereby identifying bridges and barriers to recovery.

Chapter 4: Ten bridges on the road to recovering Canada's endangered species

This chapter compares and examines the effectiveness of national endangered species assessment, listing and recovery in Canada, Australia, and the US. It identifies common barriers that have been identified and makes recommendations on ten 'bridges' to overcome these barriers in Canada to accelerate recovery.

Research objective 3: Develop and advance new approaches and paradigms to accelerate endangered species recovery in Canada.

Chapter 5: Fail to plan or plan to fail?: A survey of recovery practitioners on the challenges and opportunities to accelerate species at risk recovery in Canada

This chapter presents the results of a survey of recovery practitioners to identify successes and challenges in species at risk recovery planning and implementation. These results are analyzed to identify new opportunities to accelerate the recovery of species at risk.

Chapter 6: Synthesis: towards relationship-based wildlife recovery

This final chapter extends my final research objective, consolidates chapter recommendations, and explores opportunities for new approaches and paradigms for the practice of endangered species conservation in Canada.

CHAPTER 2. PATTERNS AND PROCESSES OF WILDLIFE EXTINCTION AND RECOVERY IN CANADA

This chapter is a manuscript in preparation and has been prepared by Daniel Kraus and co-authors: Amie Enns (NatureServe Canada), Stephen Murphy (University of Waterloo), D. Andrew R. Drake (Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada). In preparation for submission, it uses plural first-person pronouns.

Feedback on the draft chapter was provided by Derek Armitage (University of Waterloo) and Christie Whelan (Environment Canada and Climate Change).

Input, advice, and review of draft lists of ‘missing’ species has been kindly provided by: Bruce Bennett (Yukon Conservation Data Centre), Syd Cannings (Canadian Wildlife Service), Sheila Colla (York University), Jennifer Doubt (Canadian Museum of Nature), Dave Fraser (Committee on the Status of Endangered Wildlife in Canada), Chris Friesen (Manitoba Conservation Data Centre), Nathan Hentze (BC Conservation Data Centre), Damien Joly (BC Conservation Data Centre), Alex Kittle (Delaware Museum of Natural History), Colin Jones (Ontario Natural Heritage Information Centre), Troy McMullin (Canadian Museum of Nature), James Miskelly (Natural Resources Canada), Randi Mulder (Yukon Conservation Data Centre), Mike Oldham (retired) (Ontario Natural Heritage Information Centre), Steve Paiero (University of Guelph), Jenifer Penny (BC Conservation Data Centre), and Andrew Smith (Canadian Museum of Nature).

Abstract

The decline and extinction of wild species is a global crisis that affects every country, including Canada. However, despite the general trend of wildlife loss there are many examples of successful recovery. Understanding the drivers of extinction and recovery is crucial to inform conservation planning and action. Our research identifies both the species that Canada has lost since European settlement and those that have improved in status through conservation actions. We catalogued all known species losses and recoveries through a review of databases, literature, and input from experts. The timing and location of loss and recovery were determined for each species and summarized to identify general patterns and trends. We documented over 200 species that have been lost from Canada. Our findings include significantly more extinct and extirpated species than reported under Canada’s *Species at Risk Act* (SARA), although some of these extirpations are cryptic species that may be rediscovered. Canada’s extinctions are concentrated in Ontario, BC, and Quebec and align with regions harboring high numbers of species at risk. Unsustainable harvest was initially a key driver for the loss of mammals, birds, and freshwater fishes, but habitat loss and degradation later drove species loss. There are 49 species now assessed at a lower risk of extinction as result of conservation actions. Canada also has over 50 species that were historically considered threatened but recovered before official national assessments began in 1978. The main drivers of recovery are harvest management and pollution abatement, with more recent recoveries providing evidence of the effectiveness of translocations, stewardship, and protected areas. However, over 100 species have improved in status because of new discoveries. We discuss how ‘recovery by discovery’ is not conservation success and deflects resources needed to prevent and reverse extinctions. Our findings serve as a benchmark for monitoring the effectiveness of SARA and Canada’s commitments to the Kunming-Montreal Global Biodiversity Framework and national 2030 biodiversity strategy. Based on our results we present five pathways to reduce extinction and accelerate recovery including improved extinction and recovery accounting, focusing habitat protections on species with small ranges, and greater public engagement. Without urgent action to address the underlying

causes of species loss, Canada will fail to meet its national targets and global obligations to halt and reverse the extinction crisis.

2.1 INTRODUCTION

The decline of wild species is a global crisis that affects every country. Contemporary extinction rates are up to one thousand times greater than historical levels and future rates are projected to increase (De Vos et al. 2015; May & Lawton 1995). Globally, over 44,000 species are now assessed as threatened (IUCN 2023b). Many species populations are rapidly declining (Ceballos et al. 2017; WWF 2020), and up to one million species are at risk of extinction in the coming decades as a direct result of human activities (Díaz et al. 2019; Tollefson 2019).

Canada has not been immune to biodiversity loss and extinctions despite its massive geography and large areas of remaining wild areas (Watson et al. 2018). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has assessed over 800 wildlife species as at risk of extinction, and one in five species with sufficient information shows some level of risk (CESCC, 2022). The rapid and precipitous declines of many wild species have been documented in well-publicized reports (e.g., North American Bird Conservation Initiative 2012; WWF-Canada 2020; WWF Canada 2017).

Canada's *Species at Risk Act* (SARA) was enacted in 2002 as part of Canada's domestic implementation of the *Convention on Biological Diversity*. There are three purposes of SARA (s.6): *prevent wildlife species from being extirpated or becoming extinct; to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity; and, to manage species of special concern to prevent them from becoming endangered or threatened*. Under SARA, wildlife species are defined as: *a species, subspecies, variety or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus....* (Government of Canada 2002). Wildlife species listed under SARA are based on assessments by COSEWIC. COSEWIC is an independent advisory panel to the Minister of Environment and Climate Change Canada (ECCC) that assesses the status of wildlife species at risk of extinction. The Minister of ECCC then provides a recommendation to the Governor in Council if the species should be listed under SARA. COSEWIC predates SARA and began assessing wild species in 1978.

COSEWIC assesses species that are extinct and extirpated from Canada. In addition, some regional assessments of extinct, extirpated, and historical species have been prepared (e.g., Fraser 2000; Oldham 1996). However, there is currently no comprehensive accounting of species that have been lost from Canada. Canada's SARA Registry includes 45 extinct and extirpated species based on COSEWIC assessments (Government of Canada 2022). The IUCN Red List of Threatened Species lists 12 extinct taxa from Canada, including four species not in the SARA registry (IUCN 2023b). Canada's 2020 Wild Species report identifies 135 species that are presumed or possibly extirpated (CESCC, 2022), but this does not account for infraspecies as included in the SARA definition of wildlife species.

Within the pervasive trend of wildlife loss, there are also examples of recovery. Globally, conservation actions have been shown to be effective (Langhammer et al. 2024) and have prevented 21–32 bird and 7–16 mammal extinctions since 1993, and 9–18 bird and two to seven mammal extinctions since 2010 (Bolam et al. 2021). Species such as the Giant Panda (*Ailuropoda melanoleuca*) and European Bison (*Bison bonasus*) have improved in IUCN Red List status, while others including the Guadalupe Fur Seal (*Arctocephalus townsend*) and Humpback Whale (*Megaptera novaeangliae*) are no longer in an IUCN Red List risk category. Canada also has wildlife conservation success stories such as the Swift Fox (*Vulpes*

velox) (Herrero et al. 1986) and Peregrine Falcon (*Falco peregrinus anatum/tundrius*) that have improved in status based on reassessments by COSEWIC.

Wildlife extinction and recovery are integral to the Kunming-Montreal Global Biodiversity Framework (KMGBF) adopted by Canada and 195 other nations in 2022. Target 4 of the KMGBF sets to ‘*ensure urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species, to significantly reduce extinction risk...*’ (CBD, 2022a), and national extinction and recovery accounting can be used to track progress towards this target. Changes in COSEWIC status are currently tracked by the federal government as an environmental sustainability indicator (ECCC, 2023a), and changes in NatureServe ranks are reported every five years in general status reports (CESCC 2022). However, causes for status change have not been fully explored, including whether improvements in status reflect responses to conservation actions or new information on distribution or abundance.

The objectives of our research are 1) to provide a comprehensive national summary of wild species lost since European settlement and those that have improved in conservation status, 2) describe general patterns and trends, and 3) reflect on how these findings can inform species at risk recovery in Canada.

2.2 METHODS

2.2.1 CANADA’S MISSING SPECIES: AN EXTINCTION DATABASE

We developed our database of Canada’s missing species by researching and collating existing information on Canadian wild species that are extinct, extirpated, and historical (**Table 9**). We included species and infraspecies (subspecies, varieties, and populations, including designatable units identified by COSEWIC) in our database because these are included in the definition of wildlife species under SARA and other definitions of wildlife extinction including the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services¹.

¹ A population, species or more inclusive taxonomic group has gone extinct when all its individuals have died. A species may go extinct locally (population extinction), regionally (extinction of all populations in a country, continent or ocean) or globally (IPBES 2019).

Table 9: Definitions of extinct, extirpated, and historical from IUCN, SARA, & NatureServe

Extinct	IUCN: A taxon is extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form. SARA: A wildlife species that no longer exists. ¹ NatureServe: Not located despite intensive searches and virtually no likelihood of rediscovery.
Extirpated	IUCN: Not included in risk category classification. SARA: A wildlife species that no longer exists in the wild in Canada but exists elsewhere in the wild. NatureServe: Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
Historical	IUCN: Not included in risk category classification, although the tags 'Possibly Extinct' and 'Possibly Extinct in the Wild' have been developed to identify Critically Endangered species that are likely to already be extinct (or extinct in the wild), but for which confirmation is required. SARA: Not included in risk category classification. NatureServe: Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction (global or national), but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.

We used c. 1800 as the cut-off to identify contemporary species losses. This excluded species such as Steller's Sea Cow (*Hydrodamalis giga*), which occurred along the coast of BC during the Late Pleistocene but are presumed to have been lost from this range from increased Indigenous hunting before European contact (Bullen et al. 2021; Sharko et al. 2021). Species with very uncertain evidence of recent past occurrences in Canada were also excluded such as the Carolina Parakeet (*Conuropsis carolinensis*) (Prevec 1985). Species previously extirpated from Canada, and subsequently reintroduced or returned through natural dispersal were included so their initial date and causes of extirpation could be included in the analysis. Species that are extinct, extirpated, or historical from Canada that are generally accepted as vagrant and accidental (e.g., Variable Cuckoo Bumble Bee [*Bombus variabilis*]) and hybrid species (e.g., Lake Athabasca Hybrid Willow [*Salix x brachypurpurea*], Ogdens Pondweed [*Potamogeton x ogdenii*]) were excluded from the results.

Our initial list of extinct, extirpated, and historical species was prepared using data from NatureServe's Central Biotics (July 2021, updated December 2022). An Excel spreadsheet of all species recorded from Canada was filtered using national (N) ranks (Master et al. 2012) for extirpated (X) and extinct (X) species (search query : NX + NXB + NXB + NXN + NXM + NXN)² and historical (H) species (search query: NH + NHM + NHB + NHM). An additional search identified species ranked as globally (G) extinct or historical that may occur in Canada but are not ranked nationally (search query: GX + GH + NU + NNR).

¹ COSEWIC guidelines for use of Extinct or Extirpated (COSEWIC 2021b)

A wildlife species may be assessed as extinct or extirpated from Canada if: there exists no remaining habitat for the wildlife species and there have been no records of the wildlife species despite recent surveys; or 50 years have passed since the last credible record of the wildlife species, despite surveys in the interim; or there is sufficient information to document that no individuals of the wildlife species remain alive.

² Other ranks and rank qualifiers include unrankable (U), breeding (B), non-breeding (N), migration (M) and not ranked (NR). See Master 2012 for additional detail on NatureServe rankings.

The status ranking of ‘historical’ is generally applied to species that have not been observed for 20-40 years despite targeted searches (**Table 9**). However, this is not consistently applied in different jurisdictions and may be interpreted based on generation length, detectability, and search effort. There may also be species in Central Biotics that have not been observed in over 40 years but not reassessed as historical because of capacity issues in Conservation Data Centres. This initial list was cross-checked with the COSEWIC status in Species at Risk Registry (December 2022) (search query: extinct + extirpated), the 2020 general status report on wild species in Canada (CESCC, 2022) (search query: NH + NX), and IUCN Red List of Threatened Species (December 2022) (search query: Canada + extinct).

Literature searches were then conducted to identify other species that are not included in NatureServe, the Species at Risk Registry, or the IUCN Red List. The terms “extinct” or “extirpated”, and “Canada” were entered into the Web of Science, Google Scholar and in general Google search and any additional potential species from these other sources were added to our database.

The preliminary inventory of extinct, extirpated, and historical species was refined by cross-checking the scientific names and synonyms with global biodiversity databases (e.g., Global Biodiversity Facility [GBIF], Bold Systems) to search for recent records that had yet to be entered in Central Biotics. For example, Texas Thief Ant (*Solenopsis texana*) was ranked as historical for Canada by NatureServe, but there are recent collections from 2007 at Point Pelee National Park in southern Ontario. These species were then excluded from our list.

The draft list Canada’s missing species was then circulated to experts for review including Conservation Data Centres and taxa experts. New information on observations and potential status changes were incorporated into both our database and Central Biotics. For example Perforated Ruffle Lichen (*Parmotrema perforatum*) was removed from our initial list because of recent observations Nova Scotia (Belliveau & McMullin 2017), while Ottoe Skipper (*Hesperia ottoe*) was added because there have not been any observations for several decades despite targeted searches.

Each species on the updated list was then researched to determine the date of last occurrence in Canada (and globally for extinct species) and information on the conditions surrounding its disappearance. These information sources included NatureServe, the primary literature (e.g., Fraser 2000), COSEWIC assessments, IUCN Red List, and other databases (e.g., GBIF). Notably, the date of loss is very approximate, and generally represents the date of the last record. Many species likely persisted after the date of the last record but were not again recorded in subsequent searches. To provide a preliminary scan of the causes of species loss, the primary threats driving the loss of each species were identified and categorized using the IUCN taxonomy of threats (Salafsky et al. 2008). Threats were based on COSEWIC species assessments and descriptions in the literature, and a code of ‘unknown’ was added to the IUCN threat taxonomy and applied to species with insufficient information. Species were also linked to province/territory and ecoprovince or marine ecoregion (Statistics Canada 2018a, 2022) based on NatureServe subnational ranks (all included except SNA¹), location descriptions, and range maps. For birds, only the breeding range was included. Our database also includes status ranks, key information sources for each species, and a narrative summary.

A confidence code (lower, medium, higher) was initially assigned to each species by the primary author to reflect the probability of rediscovery in Canada (**Table 10**). This confidence code is based on the status, range, time since last observation, search effort, and expertise required to identify the species. The confidence codes and code descriptions were included in draft lists that were circulated to experts

¹ Not Applicable —SNA is conservation status rank is not applicable because the species is not a suitable target for conservation activities (e.g., long distance aerial and aquatic migrants, hybrids without conservation value, and non-native species (Master et al. 2012).

and these codes were adjusted based on their review. A second code was applied to species that were previously extirpated from Canada but are now extant (**Table 11**). This code also identifies the mechanism of repatriation (i.e., translocation or rescue) and success.

Data analysis to identify patterns and trends of species losses included the mapping of ‘extinction hotspots’ based on the number of missing species by province and ecoregion and quantifying the numbers of missing species by taxa and decade and causes of loss.

Table 10: Confidence codes assigned to Canada’s extinct, extirpated and historical species

Code	Code Description
L	Lower confidence. These species may have recently become historical. They may also occur in remote regions of Canada or be difficult to survey or be abundant in adjacent areas of the US. While they appear to no longer occur in Canada, there is a reasonable chance they could still occur and be rediscovered and include species that are difficult to identify, have low search effort, uncertain origin, or taxonomical issues. Examples: Muir’s Fleabane (<i>Erigeron muirii</i>), Long-spurred Meadow Katydid (<i>Orchelimum silvaticum</i>)
M	Medium confidence. These species are very likely to no longer occur in Canada. However, based on the date of the last record, taxonomical changes, or habitat availability, they could potentially still occur. Examples: Rehn’s Miner Bee (<i>Andrena rehni</i>), Large Whorled Pogonia (<i>Isotria verticillate</i>)
H	High confidence. There has been sufficient time since the last record or extensive searches for these species. If still extant, there is a very high likelihood they would have been detected, and it is highly unlikely they would ever be found again in Canada. Examples: Great Auk (<i>Pinguinus impennis</i>), Square-stemmed Rose Gentian (<i>Sabatia angularis</i>)

Table 11: Rescue and reintroduction codes assigned to Canada’s extinct, extirpated and historical species

Code	Description
R	Rescue effect: Extirpated from Canada in the wild but returned through natural rescue as their numbers outside of Canada rebounded. These species will also be included in the recovery database. Example: Northern Elephant Seal (<i>Mirounga angustirostris</i>)
TS	Translocation (successful): Extirpated from Canada in the wild but returned through translocation efforts. These species will also be included in the recovery database. Example: Swift Fox (<i>Vulpes velox</i>)
TS*	Translocation (successful, different designatable unit): Extirpated from Canada in the wild and returned through translocation efforts, but with individuals from a different designatable unit, or from unknown providence. While the species occurs, the original population is considered extinct or extirpated. Example: Atlantic Salmon (Lake Ontario population) (<i>Salmo salar</i> pop. 2)
TU	Translocation (unsuccessful): These are species that were extirpated from Canada in the wild and while returned through translocation efforts, these efforts were not successful. Example: Black-footed Ferret (<i>Mustela nigripes</i>)

2.2.2 CANADA’S CONSERVATION SUCCESSES: A RECOVERY DATABASE

We developed a recovery database by extracting information from the SARA registry (Government of Canada 2022) and COSEWIC annual reports (e.g., COSEWIC 2021a) on all species that had improved in status based on reassessments that resulted in a change to the COSEWIC risk category. The database includes species that were delisted (i.e., previously designated as at risk and then reassessed as not at risk), and species that moved to a lower risk category (e.g., threatened to special concern). Species assigned to a new designatable unit were included in the database if there was evidence of status improvement.

We also identified species that were previously in a risk category and then reassessed as ineligible or data deficient so that all delisted species were captured in the data, although this group was analyzed separately. Data deficient designation does not imply that a species is not threatened (IUCN Standards and Petitions Subcommittee 2019), although some of the species currently assessed in the data deficient category are likely not at risk (e.g. Redbreast Sunfish [*Lepomis auratus*]). We did not include species that were deactivated because of modifications or additions of designatable units.

All species reassessed in a lower risk or not at-risk categories were entered into an Excel spreadsheet. For each species, the assessment year for the highest and lowest risk category were included to calculate the number of years for the improvement in status change. We also assigned a 'trend code' based on each change in risk category that was assigned to the species by COSEWIC. Other information in the spreadsheet included range, taxonomy, and assessment criteria.

One of the primary objectives of the recovery database is to determine which species changed status as a direct result of conservation actions. The rationale for status change in COSEWIC assessment was reviewed and each species was then categorized as a 'genuine' or 'non-genuine' recovery (**Table 12**) (IUCN 2022). A 'mixed' category was assigned to species that had changed status due to a combination of genuine and non-genuine reasons but included as a genuine recovery in the final analysis to account for effective conservation actions. For example, Scouler's Corydalis (*Corydalis scouleri*) was delisted from threatened to not at risk because of the discovery of new populations (non-genuine) and because half the population was included in new protected areas that included specific management actions for this species (genuine). We identified the primary and secondary reasons (if applicable) for the status change (**Table 12**). The criteria to assign the reason for the status change code was based on determining whether status improvement would have occurred without this action.

While compounding and concurrent conservation actions occurred for many species, we limited our selection focus on the key drivers of recovery. Reasons for status change were based on information in COSEWIC assessments. If these were unclear in the assessment, other sources were consulted including recovery documents (e.g., the reason for delisting the Central Stoneroller [*Camptostoma anomalum*] in the assessment is "range expansion" but additional research found this is the result of the discovery of new locations and not a population response to conservation actions). Both the primary and secondary reasons were included in the analysis of the drivers of recovery. Some recoveries are obscured by taxonomic changes, primarily through the reassignment of species into new designatable units. This reassignment deactivates the original taxa and the assessment. For example, the Western Hudson Bay and James Bay populations of Beluga (*Delphinapterus leucas*) were once heavily harvested, and there was even a processing plant in Churchill that rendered them into pet food (Doan & Douglas 1953). It was assessed as special concern in 2004, but splitting this original designatable unit into two in 2020 with an assessment of not at risk resets the assessment status. Our analysis maintained the links between deactivated and new designatable units to identify status changes.

We catalogued the attributes of recovery based on percentage by taxa, jurisdiction, and conservation actions, and identified the length of time for recovery and if a recovery document had been prepared. To provide greater context on the state of recovery for different taxonomic groups, we calculated a Recovery Rate Index which compares the number of species downlisted and delisted for genuine reasons relative to the number of species currently assessed as at risk. We also examined the COSEWIC criteria that were applied at assessment and reassessment. However, these could only be applied to species assessed and reassessed after November 2001 when COSEWIC introduced quantitative criteria based on the revised IUCN Red List categories (IUCN 2001). These criteria are also not applied to species in the special concern risk category. We also compared the total number of recovered and missing

species for each province and territory and identified which jurisdictions had specific species at risk legislation.

Table 12: Genuine and non-genuine reasons for change in species assessment

Genuine reasons	Non-genuine reasons
Genuine reasons represent a measurable improvement in the conservation status of the species. This genuine improvement results when conservation actions successfully improved the status of the species enough to downlist it to a risk lower category. CODE: Protected Areas The establishment of new protected and conserved areas or other effective area-based conservation measures reduce immediate threats to the species. CODE: Stewardship Stewardship programs have helped to reduce threats or improve habitat conditions for the species. These may occur within protected areas or on private land. CODE: Harvest Management Laws, regulations or some other mechanism has reduced the threat of over-exploitation of a species. CODE: Legal Protection Legal protection includes specific laws and regulations other than SARA that have clearly supported recovery of a species. Legal protection may precede or overlap some actions (e.g. harvest management) and is applied to recognize legal instruments that can be clearly linked to improvement in the status of a species. CODE: Other Threat Abatement Any other actions that have reduced threats that have improved the conservation status of the species. These could include pesticide regulations or changes to river flow management. Other threat abatement is also applied to species with a recent improvement in status because of a reduced rate of decline, but the specific reason for that reduced rate is not fully understood. CODE: Translocation Direct conservation translocation efforts have increased the range, population size, or number of locations of a species. CODE: Rescue Increases in the range, population size, or number of locations of a species because of natural immigration from outside of Canada.	Non-genuine reasons for downlisting a species into a lower risk category occur when the status of the species has not been improved by conservation actions but is a result of new information or approaches to assessing the species. CODE: New Information New information has become available since the last assessment (e.g., more recent data are available on population size, number of occurrences, threatening processes, rates of decline or recovery, etc.). Does not include taxonomic revision. CODE: Taxonomic Revision There has been a taxonomic revision resulting in the species no longer being the same concept as it was before (e.g., it is now split into several species, each with smaller ranges, population sizes, etc.; or it has been merged with other species so the range, population size, etc. are now larger than they were previously). CODE: Uncertainty/ Error An error has been discovered in the previous assessment or there is now a high degree of uncertainty in the available information on the species taxonomy or occurrence. CODE: New Criteria The previous assessment used an older version of COSEWIC criteria or guidance documents. The reassessment uses the current criteria or represents a different interpretation of the criteria.

Categories adapted from IUCN (2022).

To provide a more comprehensive understanding of wildlife recovery in Canada, we also analyzed historical recoveries. These are species that were once reported as threatened but recovered or significant recovery actions were implemented prior to both the establishment of COSEWIC (1977) and enactment of SARA (2002).

Historical wildlife recoveries were identified by reviewing literature on the past status of wildlife in Canada and North America (e.g., Hornaday 1913; Matthiessen 1959; Mowat 1984; Nash 1908; Taverner 1928). In addition, Blue Lists provides key status information for birds in the 1970s and 1980s (e.g., Arbib 1971; Tate Jr & Tate 1982). COSEWIC assessment reports also provided historical accounts of the status and recovery efforts for several species (e.g., Humpback Whale [*Megaptera novaeangliae*], Sea Otter [*Enhydra lutris*]).

We reviewed these historical accounts with a focus on words that indicate a decline versus natural rarity (e.g., “becoming scarce”, “formerly abundant”). Animals that were noted as rare or uncommon in the past but have since expanded their Canadian range primarily through natural dispersal were not included (e.g., Northern Cardinal [*Cardinalis cardinalis*], Virginia Opossum [*Didelphis virginiana*]). Species and sub-species that were considered to be endangered in the past, but are no longer recognized as taxonomically valid were not included on the list, such as California Bighorn Sheep [*Ovis canadensis californiana*] (Dagg 1974). For sub-species that were not recognized in the past, the past assessment was applied to the full species and all current infraspecies (e.g., Piping Plover is now recognized as *Charadrius melodus circumcinctus*, and *C.c. melodus*). Species that are accidental to Canada were excluded.

Species that were reported to be threatened prior to c. 1980 were added to our database on historical recoveries. Current information on the species status and range was compiled using data from NatureServe’s Central Biotics (current to January 2022) and current COSEWIC and IUCN status to compare the present status to historical accounts. Species with historical accounts of rarity or decline that are now assessed as not at risk (COSEWIC) or ranked as secure by NatureServe (breeding status used for birds) were coded as ‘Legacy Recovery’ (LR). We also identified species ‘in recovery’ (IR) that were historically rare, and while they remain at risk, historical conservation actions reduced their extinction risk. Species identified as historically rare that have become extinct or have not improved in conservation status are not included.

In reviewing the historical status of Canadian species, we were aware of the biases in these narratives because many are based on first-hand qualitative accounts and observations. Early accounts of decline and calls for conservation were focused on terrestrial mammals and birds. There is also bias toward “beneficial” species that impact the early accounts of carnivores and raptors. Some of the early descriptions of endangered species were based on surveys of experts (e.g. Hornaday 1913; Tate Jr & Tate 1982), and the response (or non-response), and biases of individuals influences our historical accounts. Species that became extinct in the 1800s (e.g., Great Auk [*Pinguinus impennis*]), species with contemporary documented declines (e.g., Peregrine Falcon [*Falco peregrinus*]), or that are cryptic (e.g. Caribou dawsoni subspecies [*Rangifer tarandus dawsoni*]) are often not included in historic accounts. Early accounts of the status of plants (e.g. Argus & White 1983; Mosquin & Suchal 1977) that have improved in conservation status were not included since any improvement in status all appeared to be the result of the discovery of additional populations. Historical accounts also do not include traditional knowledge and are biased towards the locations of early collections.

We also want to acknowledge that some of these early accounts are highly racist and can be challenging to read. In particular, Hornaday’s accounts in *Our Vanishing Wildlife* falsely accuses marginalized people, including Indigenous Peoples, for the decline of wild species.

2.3 RESULTS

2.3.1 CANADA'S 'MISSING SPECIES'

Our study identified 201 species that are 'missing' from Canada. These findings include 37 species that are now globally extinct or historical, 58 species that are extirpated from Canada, and 106 species that are now historical in Canada (see **Supplementary Information, S1**).

Approximately one-third of Canada's missing species are invertebrates and one-third are vascular plants. Vertebrates make up 27% of the species lost from Canada including fishes (19), mammals (16), and birds (12). Just over 80% are full species, while the remainder are subspecies (17), varieties (vascular plants) (7), and populations (13). All but one of these populations are based on COSEWIC assessments defining designatable units. Sixteen of these species are endemic to Canada including Banff Longnose Dace (*Rhinichthys cataractae smithi*), Macoun's Shining Moss (*Neomacounia nitida*), and the stickleback pairs from Hadley Lake (*Gasterosteus* sp. 12 & 13) (Kraus et al. 2023).

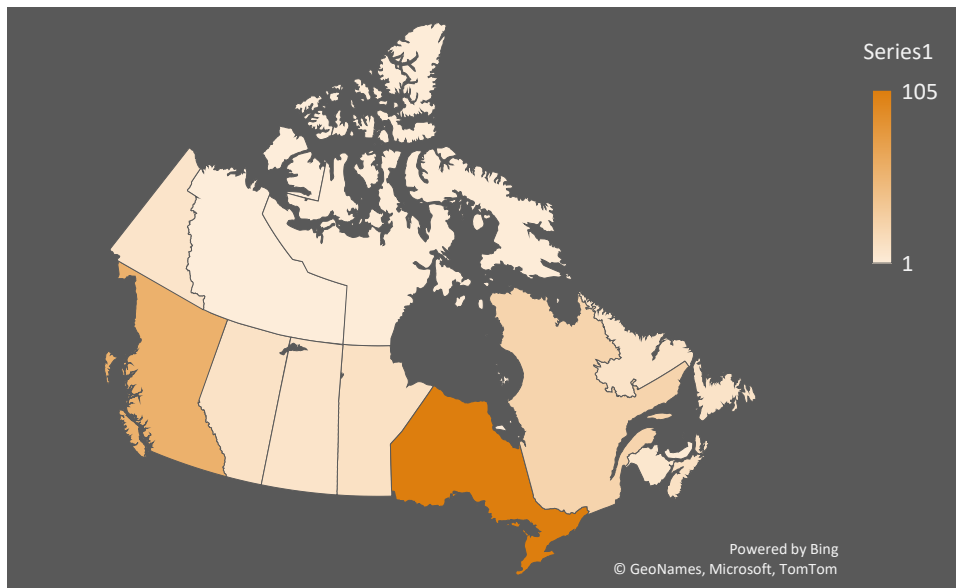
There is a high (42%) to moderate (32%) level of confidence assigned to most of the species included on our list, particularly for vertebrates, species found in southern Canada, and species that are extinct, extirpated, and globally historical. About 19% of species have a lower confidence assigned to their extinction or extirpation status. These are generally cryptic species with limited information.

Spatial patterns of extinction

Most of the species that have been lost from Canada are from Ontario, BC, and Quebec (**Figure 4**). This is expected given that these provinces have the greatest overall richness of species (CESCC 2022) and number of species at risk (Government of Canada 2022).

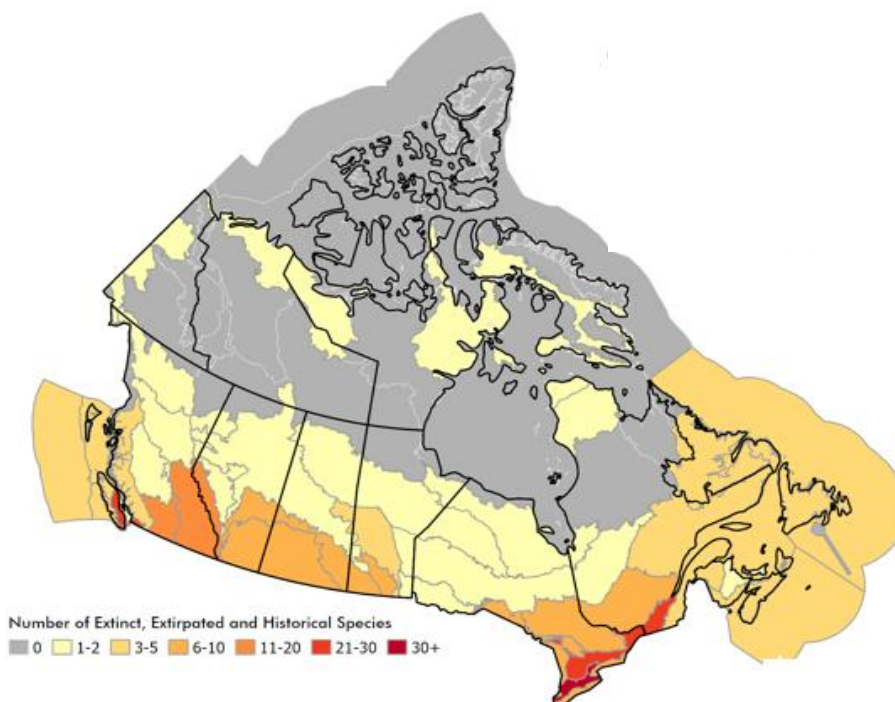
There are several hotspots of extinction across Canada based on ecoprovinces and marine ecoregions (**Figure 5**). These include the prairie ecoprovinces, Southern Boreal Shield, and the Great Lakes. Higher numbers of extinct, extirpated, and historical species occur in the southern Rocky Mountains and Okanagan-Similkameen (Southern Mountain Cordillera, Columbia Montane Cordillera), with the greatest number in the southwestern BC (Georgia Depression) and southern Ontario and Quebec (Great Lakes - St. Lawrence Lowlands, Huron-Erie Plains). The Huron-Erie Plains in southwestern Ontario has 38% of Canada's missing species, the highest of any region. Many regions with the highest number of Canada's extinct, extirpated, and historical species are within areas of high biodiversity and threat (Coristine et al. 2018) and have been identified as 'crisis ecoregions' (Kraus & Hebb 2020). As a result of these extinction hotspots, most of Canada's missing species are from single jurisdictions (provinces, territories, marine regions) (87.6%) or ecoregions (82.6%). Over half of the species that occurred in multiple jurisdictions are birds and mammals.

Figure 4: Canada's missing species, by province & territory



Number of extinct, extirpated, and historical species by province and territory. Darker shading indicates a higher number.

Figure 5: Canada's missing species, by ecoprovince and marine ecoregion



Number of extinct, extirpated, and historical species by federal ecoprovince and marine ecoregion. Map prepared by Meg Southee.

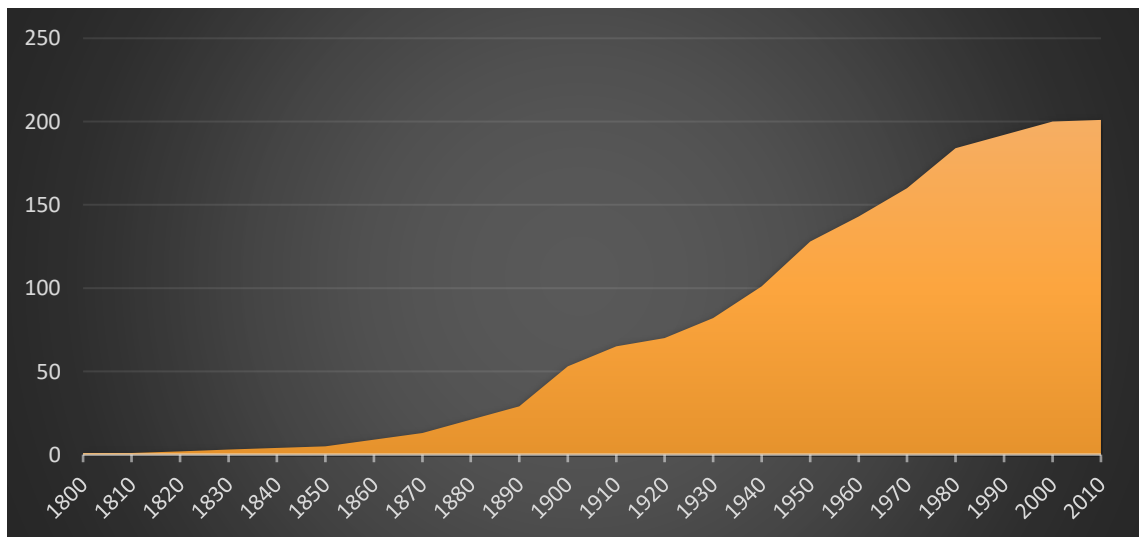
Past is prologue: an extinction timeline for Canada

The timeline of Canada's missing species extends from the extinction of the Grey Whale (*Eschrichtius robustus*) - Atlantic population (c. 1800) to the likely extirpation of the Coastal Vesper Sparrow (*Poocetes gramineus affinis*) from BC in 2014 (**Figure 6**). The first documented species losses from Canada also include the extirpation of Incurved Grizzled Moss (*Ptychomitrium incurvum*) (last documented 1825 at Niagara Falls) and extinction of the Great Auk (*Pinguinus impennis*) (last Canadian record from Funk Island in 1844, extinct by 1852). The decades with the greatest number of species lost from Canada are the 1900s, 1950s, and 1980s. The first period of accelerated extinction may partially reflect uncertainties in last date of record (i.e., "early 1900s"), but there were several last records of highly visible species including Passenger Pigeon (*Ectopistes migratorius*), Rocky Mountain Locust (*Melanoplus spretus*), and Wild Turkey (*Meleagris gallopavo*) (later reintroduced, and now common).

The post-war period of the 1950s was a period of rapid economic development in Canada. While regulations had been introduced to limit the harvest of birds and mammals (e.g., *Migratory Birds Convention Act* 1917), there were limited regulations on fisheries, and few land use or habitat protection regulations. Over half of the species lost from the 1950s are still ranked as historical, despite that over 40 years have passed since the last record (see **Table 9**). Comparable to the 1900s, the final peak in the rates of species loss in the 1980s may in part be an artefact of the data. Approximately 63% of species lost in this decade are assessed as historical as the 40-year window of absence has not fully closed. However, there are 5 (of 24) species that have been assessed by COSEWIC as becoming extinct or extirpated during this decade, and five species COSEWIC has assessed as endangered that NatureServe has subsequently ranked as extirpated or historical. The rate of loss has declined since 1990, only because species apparently absent since this time have not yet reached the threshold of 20-40 years without a record to be assessed as historical.

Since the first recorded loss of a species from Canada in 1800, species loss has continued at an average rate of almost one species a year. Approximately 77% of all species losses occurred between 1900-1980, with a rate of almost two species per year and an average increase of 17.7% per decade.

Figure 6: Timeline of species lost from Canada (by decade)



Cumulative number of extinct, extirpated, and historical species in Canada by decade. Based on date of last observation.

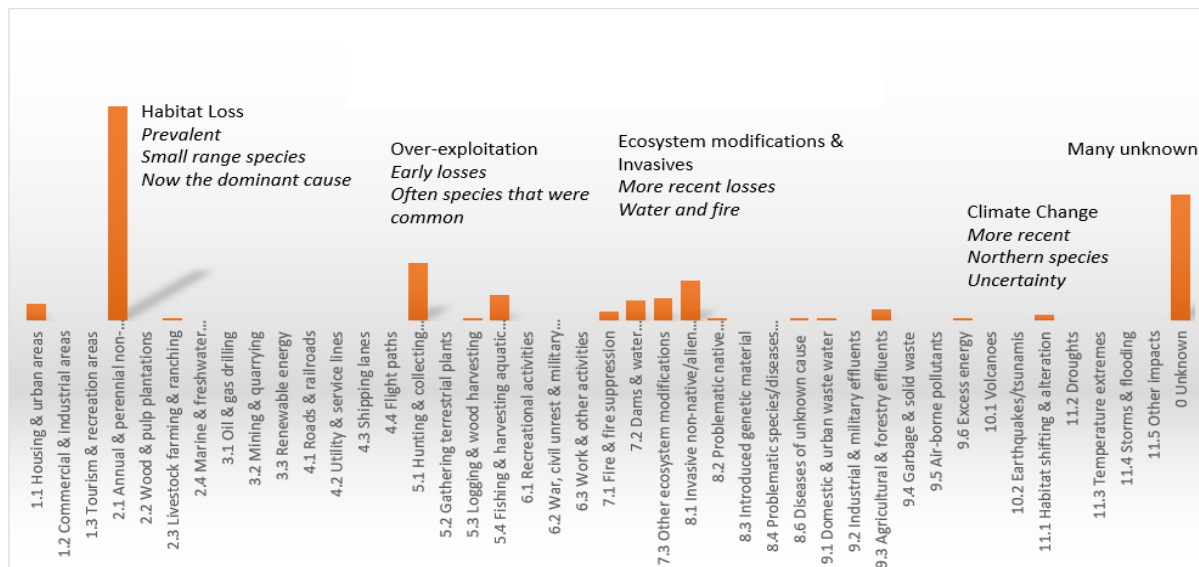
Drivers of species loss

Most species lost from Canada can be directly attributable to anthropogenic factors. The primary cause of species loss has been habitat loss for 42% of species (**Figure 7**). Habitat loss has primarily been driven by agriculture, but also urban expansion, and has been a main driver of extinction from the 1800s, until some of the most recent losses. These results are very similar to threat analyses of threatened species, that have also identified habitat loss as the primary threat both in Canada (McCune et al. 2013; Venter et al. 2006) and globally (Hogue & Breon 2022; IPBES 2019). Intense targeted commercial hunting and overfishing (unsustainable harvest) was initially a key driver for the loss of several mammals and birds (e.g., Sea Otter [*Enhydra lutris*]), and then freshwater fishes (e.g., Blue Walleye [*Sander vitreus* var. *glaucus*]). For birds and mammals, common species with migration and breeding aggregations were most vulnerable to unsustainable harvest, as well as species that likely already existed in small numbers. Overall unsustainable harvest is the primary cause for 15% of species losses but this threat has declined in recent years. More recent threats that have caused species loss include invasive species, water use, changes in fire regimes, and management and excess energy (e.g., light pollution impacting the American Burying Beetle [*Nicrophorus americanus*]).

One-quarter of the drivers of species loss are unknown. These are generally plants and invertebrates with few historical records and imprecise locations. Examples include Uhler's Camel Cricket (*Ceuthophilus uhleri*), which was last collected from Beamsville in southern Ontario in 1952 and Shiny-seed Goosefoot (*Chenopodium nitens*) that has not been recorded since 1914 when it was collected from Carcross, Yukon. Some missing species were documented from habitats that remain intact, but the driver of loss remains unknown such as the Puget Oregonian Snail (*Cryptomastix devia*) from BC and the Northeastern Bulrush (*Scirpus ancistrochaetus*), which despite targeted searches has not been seen since 1934.

Climate change has been identified as a growing threat to Canada's species at risk (Woo-Durand et al. 2020). This threat will impact species across Canada, including those in remote climate-vulnerable habitats such as the endemic Hairy Braya (*Braya pilosa*) (COSEWIC 2013). We identified two species in Canada that appear to have been lost as the result of climate change. The habitat of the Sable Island Leaf Beetle (*Tricholochmaea sablensis*) may have been altered by more extreme storm surges and rising sea levels. Siberian False Oats (*Trisetum sibiricum* ssp. *litorale*) has not been seen since the 1940s, despite targeted searches and may have become extirpated due to climate change in Yukon. Many other species with small ranges are expected to experience range contractions in this mountainous and rapidly changing region of Canada (Oke et al. 2023). While climate change is currently not a main driver of extinction (Caro et al. 2022), it has contributed to global extinctions (Cahill et al. 2013) and up to 50% of species could lose most of their suitable climatic conditions by 2100 under the highest greenhouse gas emissions scenario (Warren et al. 2018). In addition, climate change can accelerate and alter other threats, such as invasive species (Hellmann et al. 2008).

Figure 7: Key threats identified for Canada's missing species



Primary threats identified that resulted in the extinction, extirpation, and historical observations of Canadian species. Some categories truncated due to length of label. See IUCN taxonomy of threats. Notations added to highlight key threats.

Endangered or Extinct?

Our list of missing species includes 18 species that are assessed as endangered by COSEWIC that appear to no longer occur in Canada. One additional missing species is not assessed nationally but listed as Critically Endangered by the IUCN (Caribou Rams-horn [*Planorbella columbiensis*]). The last records of species still assessed as Endangered in Canada that now appear to be extinct or extirpated range from 1963 (Eskimo Curlew [*Numenius borealis*]) to 2014 (Coastal Vesper Sparrow), with half of these species last recorded between 1970-1999. This status uncertainty between endangered and extinct/ extirpated reflects the challenge in confidently declaring when a species is extinct. This is evident by the growing number of 'Lazarus' species around the world that have been rediscovered after not being seen for decades and, in some cases, after being assessed as extinct (Scheffers et al. 2011) (see Discussion).

Rescue & Reintroduction

While our analysis excluded 'Lazarus' species (since they were never actually missing from Canada), we did examine species that were previously extirpated. Six species have returned to Canada because of rescue effect as recovering populations naturally dispersed back into Canada. These include three marine mammals, two birds, and one marine fish that increased in numbers and range in response to conservation actions in the US and in the case of the Northern Elephant Seal (*Mirounga angustirostris*) and Guadalupe Fur Seal (*Arctocephalus townsendi*), also in Mexico.

Ten species have returned through conservation translocations including the Swift Fox (*Vulpes velox*) and Wild Turkey (*Meleagris gallopavo*). However, four of these species are fishes from a different stock, and the original population is assessed as extinct by COSEWIC (e.g. Striped Bass - St. Lawrence River population [*Morone saxatilis* pop. 3]; Sockeye Salmon (Adams ES population (original) [*Oncorhynchus nerka*]). Conservation translocations for Black-footed Ferret (*Mustela nigripes*) and Yellow Fringed-

orchid (*Platanthera ciliaris*) were unsuccessful, and while the species briefly returned to Canada, they are once again considered to be extirpated.

2.3.2 WILDLIFE BRIGHT SPOTS: CANADA'S RECOVERING SPECIES

Despite ongoing extirpations and extinctions, there are many examples of wildlife recovery in Canada. These span from efforts to save large mammals such as Plains Bison (*Bison bison bison*) from extinction over a century ago (Arthur 1984) to contemporary conservation efforts that reduced the extinction risk of Small White Lady's-slipper (*Cypripedium candidum*) (COSEWIC 2014). Some species remain at risk but have improved in status in response to conservation actions, while others have rebounded and are no longer considered to be at risk. Our accounting of wildlife conservation 'bright spots' (Bennett et al. 2016) provides the foundation to examine the drivers of recovery and identify practices that can be amplified to support the implementation of SARA.

Delisted: Species no longer in COSEWIC risk categories

We identified 38 species previously assessed in a risk category (endangered, threatened, special concern¹) subsequently assessed as not at risk and delisted (see **Supplementary Information, S2**). These species are almost evenly split between non-genuine and genuine reasons for delisting.

We identified 18 species delisted for **non-genuine reasons**. The most recent examples include: Seaside Bone Lichen (*Hypogymnia heterophylla*), assessed as threatened in 2008, and reassessed as not at risk in 2022 when new surveys showed a 30-fold increase in the known population, and Sonora Skipper (*Polites sonora*), assessed as special concern in 2006 and reassessed as not at risk in 2016 as a result of the discovery of new locations and field data showing it has broader food host plants than previously known. Discovery of new populations is the primary driver of non-genuine recovery that removed species from a risk category. The only two exceptions are revised taxonomy (e.g., Annual Saltmarsh Aster [*Symphotrichum subulatum*]) and new criteria (e.g., Winter Skate [*Leucoraja ocellata*] Western Scotian Shelf - Georges Bank population). The average time for non-genuine delisting of species was 16.5 years (range 5-27) and only three of these species had recovery documents prepared before they were delisted. Half of these species only occur in one province with the majority from Ontario and BC. Only one species, Seaside Bone Lichen (*Hypogymnia heterophylla*), was originally assessed using COSEWIC's quantitative criteria (under criteria D, very small or restricted population).

There are 20 species delisted for **genuine reasons**. Recent examples include Peregrine Falcon (*Falco peregrinus anatum*) anatum subspecies assessed as endangered in 1978 and reassessed as not at risk in 2017, Roughhead Grenadier (*Macrourus berglax*) (a marine fish), assessed as special concern in 2007 and reassessed as not at risk in 2018, and Beluga Whale (*Delphinapterus leucas*) (James Bay population), assessed as special concern as part of the Western Hudson Bay population in 2004 and reassessed as not at risk in 2020. Half of Canada's species delisted for genuine reasons are birds and one quarter are mammals. All delisted mammals are marine except for the Plains Pocket Gopher (*Geomys bursarius*). The remaining species are fishes (three marine, one freshwater) and a vascular plant. The primary reasons for genuine recovery that led to delisting are legal protection and harvest management. The average time for delisting of species for genuine reasons was 16.2 years (range 5-39), similar to the delisting of species for non-genuine reasons, although actions for many species were initiated prior to

¹ COSEWIC also applied the category of vulnerable and rare to species in the past. This was replaced by the term special concern in 1999.

their first assessment. Only two of the 20 species that have been delisted for genuine reasons had a recovery document. In the case of the Hooded Warbler (*Setophaga citrina*), the recovery strategy was created the same year as the species was delisted (2012). None of these species were originally assessed using COSEWIC's quantitative criteria.

In addition, we identified 17 species that were reassessed as data deficient, and one was determined to be ineligible for assessment (Aurora Trout [*Salvelinus fontinalis timagamiensis*]). Most data deficient and ineligible species were originally assessed in risk categories by COSEWIC between 1987 and 1991. Data deficient and ineligible species are identified in our analysis only to account for their former assessment in a risk category. They are not the focus of the results or included in the results or discussion.

Downlisted: Species reassessed to a lower risk category

There are 87 species that have been reassessed by COSEWIC into a lower risk category (e.g., endangered to threatened). Unlike delisted species, two-thirds of downlisted species have been reassessed into a lower risk category for non-genuine reasons (see **Supplementary Information, S2**).

We found 58 species downlisted for **non-genuine reasons**. This includes 15 species downlisted for non-genuine reasons since 2020 such as Skillet Clubtail (*Gomphurus ventricosus*), assessed as endangered in 2010 and reassessed as special concern in 2022 as the result of the discovery of new populations over a larger range, and Eastern False Rue-anemone (*Enemion biternatum*), assessed as threatened in 2005 and reassessed as special concern in 2022 as a result of COSEWIC's reinterpretation and application of the terms 'severe fragmentation' and 'area of occupancy' in the status assessment criteria. Similar to non-genuine delisting, most of the changes in status for these 58 species are the result of new information. Changes in criteria resulted in the downlisting of seven species since 2013. Non-genuine downlistings include all taxonomic groups (see **Figure 5** in Discussion). The average time for non-genuine downlisting of species was 14.2 years (range 1-28). Forty-two species had recovery documents, including 24 species that changed in status from endangered or threatened to special concern, changing the recovery planning requirements legislated by SARA from a recovery strategy to a management plan. Non-genuine downlisting of species occurred across Canada, with the majority from Ontario (25), Quebec (14) and BC (12). Twenty-five of these species were originally assessed using COSEWIC's quantitative criteria and three-quarters of these were assessed as at risk under the 'B' criteria (small range with fragmentation, decline, or extreme fluctuations). One species, Bobolink (*Dolichonyx oryzivorus*) was assessed as at risk only under A criteria (rapid decline); it was then reassessed from threatened (2010) to special concern (2022).

We identified 29 species downlisted for **genuine reasons**. The first genuine downlistings did not occur until 2003 (Harbour Porpoise [*Phocoena phocoena*], Northwest Atlantic population) and 2007 (Sea Otter [*Enhydra lutris*]). Recent examples include Ferruginous Hawk (*Buteo regalis*) (2021), Fin Whale (*Balaenoptera physalus*) (Pacific population) (2019) and Small White Lady's-slipper (*Cypripedium candidum*) (2015). Since SARA was introduced in 2002, approximately 1.4 species have been downlisted annually for genuine reasons. Half of Canada's species that have been downlisted for genuine reasons are mammals (n=10), birds (n=6) and fishes (n=5). Species have been downlisted for a variety of reasons. While traditional wildlife conservation practices such as harvest management that often began decades before SARA are the primary driver, translocations, stewardship, and protected areas have also contributed to downlisting. The most common downlisting is from the status of threatened to special concern (n=17). Most genuine downlistings have occurred in BC (12), Ontario (9) and Manitoba (9). Downlistings in Ontario and Quebec are primarily driven by birds that showed lower rates of decline at reassessment. The average time for genuine downlisting of species was 17.8 years (range 2-41), although in some cases, such as Ferruginous Hawk (*Buteo regalis*) there were multiple down and up-

listings during this period. Sixteen species downlisted for genuine reasons had a recovery document, with an average of four years between the release of the final recovery document and reassessment into a lower risk category. However, in seven cases, recovery documents were published the same year or after the reassessment into a lower risk category. For example, Prairie Skink (*Plestiodon septentrionalis*) was assessed as endangered in 2004 and reassessed as special concern in November 2017. The recovery strategy was finalized in 2019, and a draft management plan has now been prepared in 2023. There is no difference in the period for recovery between species with a recovery document and those that do not, possibly because recovery actions had already started at the provincial level. Seventeen of the species downlisted for genuine reasons were originally assessed using COSEWIC's quantitative criteria. Unlike non-genuine recoveries, most (71%) of these species were assessed under the A criteria and conservation actions slowed or reversed their declines.

Attributes of Recovery

We identified 49 species that have improved in conservation status because of genuine reasons between the first COSEWIC assessments in 1978 and 2022. Many conservation actions for species delisted or downlisted for genuine reasons were initiated long before the establishment of COSEWIC and SARA, particularly for birds and mammals (see next section on historical recoveries). For example, Trumpeter Swan (*Cygnus buccinator*) (not at risk), Sea Otter (*Enhydra lutris*) (special concern) and Plains Bison (*Bison bison bison*) (threatened) have over a century of conservation efforts and were the only species from Canada included in the first global species assessments (Scott 1965). As a result of these early conservation actions, Canada's wildlife recoveries are dominated by birds and mammals which represent almost two-thirds of genuine species recovery. Other species groups, such as vascular plants, continue to receive less funding and are underrepresented in federal programs (McCune & Morrison 2020). Assessments and actions for plants, reptiles, amphibians, and invertebrates did not begin until later in the 20th century (e.g., Cook 1970; Mosquin & Suchal 1977). Their recovery progress lags, in part, because COSEWIC assessments of some species groups (e.g., lichens) only began in 1994. While taxa other than birds and mammals are currently the minority of species recoveries in Canada, recovery of these species is increasing.

To provide greater context on the state of recovery we propose a Recovery Rate Index (RRI). RRI is a simple comparison of the number of species downlisted and delisted for genuine reasons relative to the number of species currently assessed as at risk by taxonomic group (**Table 13**). The high RRI for birds and mammals and a very low RRI for other groups shows the imbalance in the success of recovery actions and historical focus on mammals and bird conservation.

Table 13: Summary of species by taxa that have been assessed in a lower risk category for genuine reasons

Taxa	Delisted	Downlisted	Total Genuine Recoveries	Number currently assessed as at risk by COSEWIC*	Recovery Rate Index
Amphibian	0	1	1	28	0.0357
Arthropods	0	0	0	80	0.0000
Birds	10	6	16	91	0.1758
Fishes	4	5	9	212	0.0425
Lichens	0	0	0	23	0.0000
Mammals	5	10	15	79	0.1899
Mollusks	0	2	2	45	0.0444
Mosses	0	0	0	21	0.0000
Reptiles	0	2	2	50	0.0400
Vascular Plants	1	3	4	214	0.0187
Total	20	29	49	843	0.0581

Assessed as extirpated, endangered, threatened, or special concern by COSEWIC (January 2023).

Downlisting in Canada began to accelerate starting in 2010, with up to eight species downlisted annually since that time. The time to downlist species is partially driven by the timing of COSEWIC reassessments, which is generally scheduled every ten years. However, COSEWIC prioritizes reassessments, in part, based on species that are likely to be experiencing increased threats and worsening population and distribution trends. This may delay the reassessment and reporting on status improvements for some species.

Species have improved in conservation status across Canada (**Table 14**), with the highest numbers in Ontario, BC, and Manitoba. Ontario and BC have the greatest richness of species and species at risk in Canada, creating more opportunities for recovery. Manitoba encompasses a diversity of ecosystems that include both eastern and western species that have recovered over their entire range. These three provinces also have the greatest number of single jurisdiction recoveries. Single jurisdiction recoveries are generally for species with smaller ranges (except for marine species) and account for approximately 40% (20/49 species) of all genuine recoveries in Canada. Recovery times are similar between single jurisdiction species (17.3 years) and multiple jurisdiction species (17.1 years), however, recovery actions for many multiple jurisdiction species began well before COSEWIC assessments. Protected areas, stewardship, and translocations contributed to the recovery of 60% of single jurisdiction species, while these same actions contributed to the recovery of only 24% of multiple jurisdiction species. We note that occurrence in multiple jurisdictions is not always a proxy for large range but does apply in most cases (Small White Lady's-slipper [*Cypripedium candidum*] is a notable exception with a very small range and population in both Ontario and Manitoba).

Table 14: Genuine recoveries by number of jurisdictions (provinces, territories, marine regions)

Jurisdiction	Delisted	Downlisted	Total	Single Jurisdiction	Two Jurisdictions	Three+ Jurisdictions
BC	7	12	19	6	2 (both marine)	11
AB	6	8	14	1	1	12
SK	6	7	13	0	1	12
MB	8	9	17	3	1	13
ON	11	9	20	5	1	14
QC	8	8	16	0	0	16
NB	6	7	13	0	0	13
NS	5	7	12	0	0	12
PE	2	7	9	0	0	9
NL	5	6	11	1	0	10
YT	3	5	8	0	0	8
NT	5	6	11	0	2	11
NU	5	6	11	0	2	11
Atlantic Ocean	4	3	7	0	1	6
Arctic Ocean	4	2	6	1	2	3
Pacific Ocean	2	4	6	3	2	1

Jurisdictions based on 'range' in Species at Risk Registry. Species occurring in multiple jurisdictions are included in each jurisdiction.

Ten of the 49 species that have been delisted or downlisted because of genuine reasons showed recovery progress in under a decade. These 'rapid recoveries' were driven by two key reasons. Harvest management resulted in reduced threats to three marine fishes and new protected and conserved areas contributed to the improved status of species with small ranges including Rocky Mountain Tailed Frog (*Ascaphus montanus*) and Lyall's Mariposa Lily (*Calochortus lyallii*). Both actions can provide rapid threat abatement and reduced risk of extinction for some species.

Although almost two-thirds (31/49) of species that recovered for genuine reasons did not have a recovery document, or final documents were released after the species was delisted or downlisted, effective conservation actions occurred to support recovery of these species. Most recovery is the result of harvest management (31%) and other threat abatement (35%) (**Table 15**). Other threat abatement captures improvements in water quality and reduced rates of decline that cannot be attributed to a specific action. Many actions relating to birds and mammals, as discussed above, were initiated before SARA. Protected and conserved areas and stewardship contributed to the status improvement for 16% of species that have recovered for genuine reasons. Protected areas have contributed to the recovery of species with small ranges including Plains Pocket Gopher (*Geomys bursarius*) and Rocky Mountain Tailed Frog (*Ascaphus montanus*). Stewardship actions have made important contributions to the recovery of species such as Eastern Bluebird (*Sialia sialis*) and Western Blue Flag (*Iris missouriensis*). There are only three species where rescue has contributed to improvement in conservation status, although as discussed in the preceding section on missing species, rescue has contributed to the return of additional species to Canada (e.g., Northern Elephant Seal [*Mirounga angustirostris*]).

Table 15: Reasons for recovery: genuine reasons for reassessment in a lower risk category

Reason Code	Delisted Species	Downlisted Species	Total Species
Harvest Management	7	8	15
Legal Protection	5	2	7
Other Threat Abatement	6	11	17
Protected Areas	2	7	9
Rescue	2	1	3
Stewardship	3	3	6
Translocation	2	5	7

There are many pathways to improved conservation status, and not all have been linear. Most of the 49 species that we identified with improved conservation status were species reassessed from special concern to not at risk, and species reassessed from threatened to special concern (**Table 16**). Seven species improved in status by two categories between assessments. This can result from ‘rapid recovery’ actions that abate critical threats (e.g., Scouler’s Corydalis [*Corydalis scouleri*]), but is also a result of delayed reassessments (e.g., Humpback Whale [*Megaptera novaeangliae*] Western North Atlantic population). Of the 11 species that have been reassessed three or more times, five showed linear progress towards improved conservation status, while six are ‘roller-coaster’ assessments that showed improved, then declined, then improved conservation status. Only Swift Fox (*Vulpes velox*) was assessed as extirpated and then improved in conservation status after reintroduction. Although there are fishes that were extirpated and reintroduced, the stock was later deemed to be from a different designatable unit, and the species is reassessed as extinct. Interestingly, the most common pathway to improved conservation status that we identified (special concern to not at risk) is not explicit in the purpose of SARA, which is to ‘*manage species of special concern to prevent them from becoming endangered or threatened*’ rather than management for reassessment as not at risk.

Table 16: Status changes for recovered species

Status Change	Number of Species
Special Concern- Not at Risk	15
Threatened-Special Concern	11
Endangered- Threatened	4
Threatened- Not at Risk	4
Endangered-Special Concern	3
Endangered- Threatened- Special Concern	3
Threatened-Endangered-Threatened	2
Threatened- Special Concern- Not at Risk	1
Not at Risk-Threatened -Endangered- Threatened- Special Concern	1
Special Concern-Endangered- Special Concern	1
Special Concern-Endangered-Threatened	1
Special Concern- Threatened-Special Concern	1
Threatened-Special Concern-Threatened -Special Concern	1
Extirpated-Endangered-Threatened	1
Total	49

Status change history for each species delisted or downlisted for genuine reasons.

2.3.3 SPECIES AT RISK RECOVERY BEFORE THE SPECIES AT RISK ACT

Our review of species that were identified as being at risk prior to c.1980 identified 41 birds and 13 mammals that are ‘legacy recoveries’. These species were recognized as being at risk of extinction in the past and showed improved conservation status prior to the *Species at Risk Act* (2002) and the first COSEWIC assessments (1978) (see **Supplementary Information**, S3). This includes American White Pelican (*Pelecanus erythrorhynchos*) that was noted to ‘shortly be extinct’ in the early 1900s (Taverner 1928) and the Northern Elephant Seal (*Mirounga angustirostris*) that was thought to have been extinct by the late 1800s (Huey 1930).

We identified 37 historically threatened species that are still at risk. These include 25 species currently assessed as endangered, threatened, or special concern by COSEWIC. Conservation efforts prior to SARA and COSEWIC have likely prevented their extinction (e.g., Whooping Crane [*Grus americana*]) or have improved conservation status (e.g., Wood Bison [*Bison bison athabascae*]).

Two birds historically documented as threatened in Canada are now extinct (Passenger Pigeon [*Ectopistes migratorius*]) or extirpated (Greater Prairie Chicken [*Tympanuchus cupido*]). There are few historical accounts of endangered plants (Mosquin & Suchal 1977), non-commercial freshwater fishes (McAllister 1970), and reptiles and amphibians (Cook 1970) in Canada prior to the establishment of COSEWIC and limited historical actions to recover these species groups.

Historical conservation actions drove the improved status of many birds and mammals that were later assessed by COSEWIC. Historically threatened species have recovered primarily as the result of harvest management and legal protection. Many seabirds and marine mammals, particularly in eastern Canada, were heavily exploited for centuries following European colonization (Mowat 1984). There was also significant concern that several furbearers were becoming extinct. Seabirds, game animals, and furbearers were subject to some of the first wildlife game management laws in Canada, followed by marine mammals (see **Chapter 1**).

Historic conservation concern for some ‘legacy recovery’ species almost seems unbelievable today given their current distribution and abundance. Species such as Canada Goose (*Branta canadensis*), Wild Turkey (*Meleagris gallopavo*) and North American Beaver (*Castor canadensis*) are not only now secure but sometimes considered nuisance species. Many historically threatened species have also shown a remarkable adaptive response to dramatic habitat changes and now thrive in novel ecosystems (Hobbs et al. 2006). Cooper’s Hawk (*Accipiter cooperii*) and Pileated Woodpecker (*Dryocopus pileatus*) are examples of this adaptive response. Both were historically associated with large forests, but now also occupy urban areas. Because of reduced persecution and their adaptation to a modified landscape, they are now common and secure.

2.4. DISCUSSION

2.4.1 WILDLIFE LOSS AND RECOVERY IN COMPLEX SOCIAL-ECOLOGICAL SYSTEMS

Our accounting of Canada’s missing and recovered species provides a comprehensive and contemporary national ledger of wildlife conservation successes and failures. Canada has over 100 species that have recovered because of conservation actions, but over 200 species are now extinct, extirpated, or historical. Our results mirror the current status and trends of biodiversity conservation in Canada (Office of the Auditor General of Canada 2022), including Canada’s most recent reporting on biodiversity targets (ECCC 2023e): while there are many hopeful examples of recovery, the loss of wildlife is continuing.

The drivers of species loss and recovery are complex. Today, there are new threats facing wildlife, such as climate change, that will require a transformation of political and economic systems (Dasgupta 2021) and braiding of Indigenous knowledge (e.g., Salomon et al. 2023) to solve. However, many of the past recoveries also occurred within complex social-ecological systems that required significant governance and cultural transformations. Canada's first wildlife recovery actions focused on harvest regulation (e.g., quotas, seasons) and these have been particularly effective for waterfowl, marine mammals, and furbearers. Many migratory bird populations rebounded because of bans on commercial hunting and harvest regulation after the *Migratory Bird Convention Act* was enacted in 1917. Some of Canada's first conservation efforts also included the establishment of protected areas for migratory birds (e.g., Last Mountain Lake, 1887), large mammals (e.g., Thelon Wildlife Sanctuary, 1927) and furbearers (e.g. Algonquin Provincial Park, 1893).

Many historical recoveries were also supported by translocations to re-establish rare and declining animals, including in 1906 when Canada imported 695 Plains Bison (*Bison bison bison*) from one of the last remaining herds in Montana (Foster 1998). In addition to harvest regulation, protected areas, and translocations, many birds have also benefited from the reduction of pollution, in particular DDT (e.g. Osprey [*Pandion haliaetus*], Bald Eagle [*Haliaeetus leucocephalus*]). The recovery of birds was supported by engagement efforts that changed public opinion. Advocacy by the Audubon Society and others amidst the decline of bird populations for sport and fashion (Doughty 1975) led to laws that better protected migratory birds. The Brodie Club (an Ontario naturalist organization) called for conservation of birds of prey and critiqued the views of Jack Miner (a well-known advocate for waterfowl conservation) helping to change attitudes towards raptors (The Brodie Club 1931). Birds have also been the focus of direct citizen action. The recovery of both the Osprey (*Pandion haliaetus*) and Eastern Bluebird (*Sialia sialis*) was supported by nature clubs and other organizations that provided artificial nesting structures (Poole 2019).

Through a contemporary lens, harvest regulations, protected areas, and public engagement are standard conservation actions, but at the time they were novel, controversial, and transformational (Green 1976). And while these actions have proven impact in halting and reversing the loss of over 100 species, they have not been sufficient to stop the loss of biodiversity. Our discussion focuses on two key areas: the implications of our findings for species risk assessments and policy in Canada, and new pathways for wildlife recovery.

2.4.2 IMPLICATIONS FOR SPECIES AT RISK ASSESSMENTS AND POLICY

Our results show that SARA and supporting provincial/territorial species at risk legislation is having mixed results in Canada. While the status of some species is genuinely improving, the purpose of SARA to prevent wildlife species from being extirpated or becoming extinct (s.6) is not being fully met. Here we explore how these results can be applied to species assessments and species at risk policy to improve conservation outcomes for endangered wildlife.

Canada's extinction debt

Our results show that Canada has lost more wildlife species than reported and that trends of species loss are continuing. In addition to the 201 missing species we identified, there is an increasing number of species that are on the edge of extinction, or may already be gone from Canada, but have not been reported. Both Fragrant Popcornflower (*Plagiobothrys figuratus*) (last observed at Cape Gurney on Hornby Island in 2005 (COSEWIC 2008) and Gray-headed Chickadee (*Poecile cinctus*) (Bruce Bennet pers. comm.), may have disappeared from Canada. Other species such as Spotted Owl (*Strix occidentalis caurina*) are, if not gone from Canada, already functionally extirpated.

Currently one in five of species in Canada is at some level of extinction risk (CESCC 2022) and almost 1000 species have been ranked as critically imperiled in Canada by NatureServe. In addition, approximately 30,000 species lack information needed for ranking. Globally, it has been estimated that over half of the species assessed on the IUCN Red List of Threatened Species as data deficient are at risk of extinction (Borgelt et al. 2022). Our results on Canada's missing species are conservative and likely to grow as more species are lost and with new information on the status of species. The magnitude of Canada's 'extinction debt' (Blanchard & Munoz 2022; Tilman et al. 1994) will continue to grow, without significant intervention, compromising the purpose of SARA and Canada's commitments under the Kunming-Montreal Global Biodiversity Framework.

Extinction is a tough call to make, but it needs to be made

Our results on missing species highlight that the number of species listed under SARA that are extinct and extirpated is likely higher than currently reported. Of the 44 species assessed as extirpated or extinct by COSEWIC, our list of missing species includes 16 species still assessed as endangered, but likely no longer occurring in Canada (**Table 17**). For example, Blanchard's Cricket Frog (*Acris blanchardi*) is assessed as endangered by COSEWIC (last assessment 2011) but is ranked as extirpated by NatureServe since the last Canadian record was in 1987. While COSEWIC guidelines for assessing a wildlife species as extinct or extirpated include a period of 50 years since that last credible record (see **Table 9**), many of these occur in small habitat areas that have been thoroughly surveyed. For most of endangered species that are likely extirpated or extinct, recovery strategies were finalized after the species disappeared from Canada (**Table 17**).

Table 17: Species assessed as endangered in Canada that are ranked as extirpated or extinct by NatureServe

Scientific name	Common name	Last observation	Year of First Final Recovery strategy
<i>Acris blanchardi</i>	Blanchard's Cricket Frog	1987	2011
<i>Bombus affinis</i>	Rusty-patched Bumble Bee	2009	2020
<i>Coregonus reighardi</i>	Shortnose Cisco	1985	2012
<i>Epilobium torreyi</i>	Brook Spike-primrose	1993	2013
<i>Eremophila alpestris strigata</i>	Streaked Horned Lark	2002	2016
<i>Erynnis persius persius</i>	Eastern Persius Duskywing	1987	2019
<i>Fabronia pusilla</i>	Silver Hair Moss	1968	2008
<i>Gasterosteus sp. 2</i>	Enos Lake Limnetic Threespine Stickleback	2013	2007
<i>Gasterosteus sp. 3</i>	Enos Lake Benthic Threespine Stickleback	2013	2007
<i>Hesperia ottoe</i>	Ottoe Skipper	1986	2010
<i>Icaricia saepiolus insulanus</i>	Vancouver Island Blue	1979	2008
<i>Isotria verticillata</i>	Large Whorled Pogonia	1996	2017
<i>Lasthenia glaberrima</i>	Rayless Goldfields	2006	2012
<i>Numenius borealis</i>	Eskimo Curlew	1963	2007
<i>Poocetes gramineus affinis</i>	Coastal Vesper Sparrow	2014	2007
<i>Scouleria marginata</i>	Margined Streamside Moss	1977	2008

Some ‘missing’ species assessed as endangered, such as Brook Spike-primrose (*Epilobium torreyi*) and Rayless Goldfields (*Lasthenia glaberrima*) require further field studies to confirm their status, and birds that appear to have been recently extirpated could be subject to future rescue, but there are several species currently assessed as endangered in Canada that have a higher probability of being extirpated including species that can be readily surveyed and previously occurred in small areas. However, declaring a species as extinct or extirpated is fraught with uncertainty and challenges. The consequences of erroneously declaring a species extinct or extirpated are greater for COSEWIC compared to NatureServe, which results in a high degree of precaution. The precautionary approach is partially driven by concern of committing a ‘Romeo error’ (Collar 1998) where a species is declared extinct and subsequently rediscovered. This would have financial and reputation risks for SARA and erroneously remove protections for species that have a chance of persisting. Extinction can be difficult to determine, and no international guidelines have been developed to assess when a species has become extinct (Akçakaya et al. 2017). Unlike other risk categories applied in IUCN and COSEWIC assessments, the category of ‘extinct’ does not have quantitative criteria and relies on expert inference of factors including data availability, time from the last sighting, detectability, search effort, habitat availability, and population decline (Roberts et al. 2023)

This precautionary approach is supported by many examples of ‘rediscovered’ species. Globally, there is a growing list of examples of ‘Lazarus’ species that have been rediscovered after not being seen for decades or even assessed as extinct (Scheffers et al. 2011). In 2022, researchers rediscovered the black-naped pheasant-pigeon (*Otidiphaps insularis*), native to Papua New Guinea, that had not been seen for 140 years. That same year, researchers in the US rediscovered a species of oak (*Quercus tardifolia*) that was thought to have gone extinct over a decade earlier. In Canada, Glossy Valvata (*Valvata humeralis*) (a mollusc) was first documented from southeastern BC in 1883, but was not reported again until 2012 (BC Conservation Data Centre 2014). In 2021, NatureServe updated the rank of a hornwort (*Anthoceros fusiformis*) originally believed to have been last collected in Canada in 1914 from historical to vulnerable based on new collections.

One of the key challenges is the amount of data and field effort that is required to document population trends and declare extinction with a high level of confidence and with limited resources, assessment and reassessment of species that are likely extinct and extirpated is not priority. As of 2023, only two species have been reassessed as extinct or extirpated and this resulted from reinterpretation of taxonomy and criteria. Listing a species as extinct or extirpated under SARA also admits failure but provides essential information on the state of biodiversity in Canada, and in the case of extirpated species can mark a starting point for reintroduction efforts. Nondisclosure of species loss and extinction can mask political failures, and real conservation solutions in favor of the status quo (Armoudian & Poulsen 2023) and impede implementation and reporting of Canada’s nature strategy.

The costs of ‘recovery by discovery’

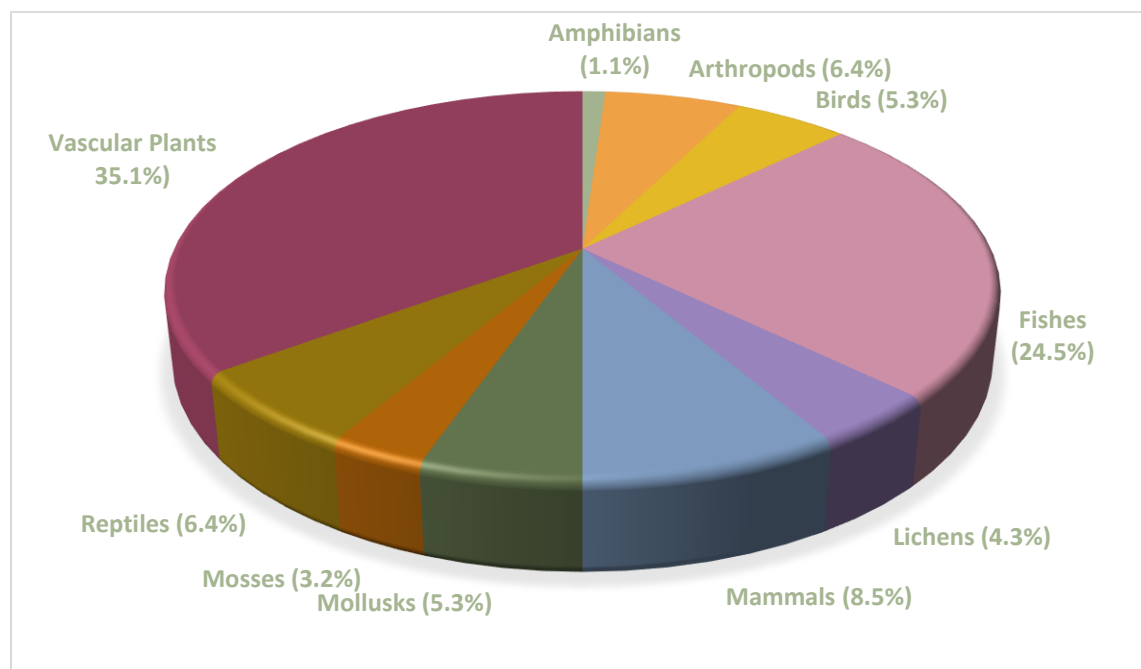
Non-genuine status changes are inevitable and will occur as the result of taxonomic revisions and criteria updates. However, we identified that almost 61% of species downlisted or delisted by COSEWIC resulted from the discovery of new populations. These are often cryptic species with limited baseline information that are difficult to identify and require targeted methods or are challenging to survey on the private land base of southern Canada. It is important that ‘recovery by discovery’ improvements in conservation status are not conflated with recovery. Non-genuine improvements in conservation status artificially inflates Canada’s current reporting on recovery progress (ECCC 2022a) and confounds the assessment of the effectiveness of conservation actions.

'Recovery by discovery' is not new or limited to Canada. Historical accounts of some rare species are influenced by limited data, and the first Red Lists include species from Canada that have subsequently been shown to be more common and stable because of better sampling and data consolidation (e.g., Incurvate Emerald [*Somatochlora incurvata*] was assessed as rare in 1986 and least concern in 2006). Most species delisted from Australia's *Environment Protection and Biodiversity Conservation Act* are primarily due to taxonomic changes or new information that indicates that the taxon was never eligible for listing as threatened (Woinarski et al. 2023). In the US, of the 104 domestic species (including 11 extinctions) that have been delisted from the *Endangered Species Act*, seven have been removed because of new information, while 59 have been delisted as the result of recovery. Other reasons for delisting under the ESA include Act amendments and taxonomical revisions (USFWS 2024). Change in conservation status due to new discoveries should be encouraged and celebrated, but it needs to happen earlier in the species at risk conservation cycle (ECCC 2018a).

Our data on non-genuine status improvements can be used to flag candidate species for assessment that have a higher probability of future status improvements because of new information. While 'recovery by discovery' occurs across all taxonomic groups (**Figure 8**), it is highest in vascular plants, fishes, arthropods, mosses, and lichens. We strongly encourage species assessments to incorporate and rank the detectability of species and examine the probability that additional populations may be discovered after the assessment process. To reduce 'recovery by discovery' species that have a high probability of being under-surveyed should have a different assessment approach. This could include developing habitat models to predict probable distribution (Santini et al. 2019) and increasing resources for field surveys before assessments. Citizen science can be better harnessed to collect population and distribution information in advance of species assessments. Citizen science already provides new and important information for birds (through eBird) and could be expanded to some other taxa by actively recruiting assistance to submit observations of COSEWIC candidate species before they are assessed.

While more complete surveys require additional resources, they are an investment in avoiding the high costs incurred by 'recovery by discovery' status changes. Species listed as 'endangered' or 'threatened' result in estimated costs of \$20,000 - \$25,000 to develop the recovery strategy. New listings or reclassification as 'special concern' are estimated to cost \$10,000 to \$15,000 to prepare management plans (Government of Canada 2023). This does not include translation costs of documents which can be over \$10,000 per document and costs for other background studies (e.g., recovery potential assessments for aquatic species). The assessment and listing of species that subsequently improve in status for non-genuine reasons reduces resources that could be directed towards species with genuine conservation needs.

Figure 8: Non-genuine recoveries in Canada, proportion by taxa



The percentage of each taxa by total number of non-genuine recoveries.

Does policy and planning matter?

Conservation policies and laws are important because they codify priorities and values and drive the establishment of the institutions, programs, and governance (Swerdfager & Olive 2023). Specific laws for endangered species protection in provinces and territories can provide important legislative signals to their constituencies and develop improved and novel approaches to endangered species conservation (e.g., Manitoba's inclusion of endangered ecosystems in the *Endangered Species and Ecosystem Act*). However, specific species at risk legislation within a particular province or territory may not be a significant barrier to recovery or shield from species loss.

Under SARA the federal government has authority for some species, with provinces and territories responsible for the recovery of the majority of species at risk. Some provinces and territories had endangered species legislation prior to SARA, others introduced new legislation, while others rely on existing wildlife legislation (see **Chapter 1**). Species losses and recoveries have occurred across all jurisdictions, and there is no clear trend that jurisdictions with specific species at risk legislation have fewer missing species or more species recoveries (**Table 18**). Provinces such as BC and Alberta have programs to recover species at risk under existing wildlife legislation and both have examples of species at risk recovery under SARA, and many historical recoveries occurred without any legislative requirements. When the total number of species at risk is provided as context, Ontario (species at risk legislation) and BC (no species at risk legislation) offer a comparison of Canada's two most biodiverse provinces. Both have similar numbers of recovered species, while Ontario has almost twice as many missing species despite having the oldest endangered species legislation in Canada (*Ontario Endangered Species Act 1971*).

Table 18: Missing and recovered species by jurisdiction in Canada

Jurisdiction	Total number of Species at Risk ¹	Total missing species	Total genuine recoveries	Recovery rate index	Specific species at risk legislation
BC	465	57	19	0.0409	No
AB	197	11	14	0.0711	No
SK	180	9	13	0.0722	No
MB	194	12	17	0.0876	Yes
ON	428	105	20	0.0467	Yes
QC	254	24	16	0.0630	Yes
NB	140	7	13	0.0929	Yes
NS	153	12	12	0.0784	Yes
PE	68	3	9	0.1324	No
NL	116	10	11	0.0948	Yes
YT	96	9	8	0.0833	No
NT	107	9	11	0.1028	Yes
NU	80	2	11	0.1375	No
Atlantic Ocean	67	6	7	0.1045	Yes ³
Arctic Ocean	21	0	6	0.2857	Yes ³
Pacific Ocean	89	4	6	0.0674	Yes ³
Great Lakes	Unknown ²	6	6	-	Yes ³

Total number of species at risk by jurisdiction, current to January 2023.

¹COSEWIC assessed: endangered, threatened, special concern

²Cannot be queried in Species at Risk registry

³Marine and freshwater regions with federal responsibility under SARA

Recovery planning is a cornerstone of SARA and follows the protection of species at risk under the Act in Canada's species at risk conservation cycle (ECCC 2018a). Recovery planning is intended to be a two-staged process that involves the development of scientifically sound and credible goals, objectives and strategies for the survival and recovery of species at risk and their habitats, and identification of appropriate measures and actions to effectively achieve those goals. SARA has been criticized for not listing species within legislated timelines, which delays the preparation of federal recovery documents (Ecojustice 2012; Mooers et al. 2010). An audit by the Office of the Auditor General (OAG) in 2013 found that 146 of 360 (40.5%) recovery strategies for species at risk were overdue (Office of the Auditor General of Canada 2013). However, by 2022, the OAG found that just 10% (or 61) of the 627 species listed as extirpated, endangered, threatened, or of special concern did not have recovery strategies or management plans in place as required by the Act and that recovery strategies were overdue for 36 species, and management plans were overdue for 25 species (Office of the Auditor General of Canada 2022). Although these numbers do not account for delays in listing species under SARA that have been assessed as at risk by COSEWIC (Findlay et al. 2009; Turcotte et al. 2021), there has been an improvement in agencies responsible for recovery planning in meeting legislative timelines. Recovery strategies and management plan publication were not funded or a priority before 2014 (when a 3-year plan was enacted to clear the backlog) and we expect that the disconnect between listing and planning will improve in the future. While the timing of recovery planning has been a central issue for implementation of SARA, our analysis can begin to address the fundamental question of the impact of recovery planning on reducing extinction risk.

There is limited evidence that recovery documents have played a role in the recovery of species at risk given that 63% of species that improved in conservation status for genuine reasons did so without a

recovery strategy or management plan, or final documents were released after the species was delisted or downlisted. Local and regional conservation practitioners may have already initiated actions, or effective actions were triggered by the assessment and listing of species under SARA (e.g., Small White Ladies-slipper [*Cypripedium candidum*]). Rapid recoveries from a single action that removes key threats, such as habitat protection (e.g., Prairie Skink [*Plestiodon septentrionalis*], Lyall's Mariposa Lily [*Calochortus lyallii*]) or harvest restrictions on marine fishes (e.g., Pacific Sardine [*Sardinops sagax*]), can occur before recovery documents are prepared. In addition, many species that have improved in status are birds and mammals that have a long history of conservation, and most recovery actions occurred prior to SARA. In addition, recovery strategies were prepared for 18 species that are likely extirpated or extinct (although still listed as endangered under SARA) (**Table 17**). Except for three species, recovery plans were prepared after the species likely disappeared and these recovery plans are essentially calls to action that came too late.

While many species have technical and knowledge barriers that need further research to advance their recovery (Drake et al. 2021), effective actions needed to conserve many species are generally known (Bolam et al. 2021; Langhammer et al. 2024) and many on-the-ground recovery practitioners in Canada are implementing recovery actions before recovery strategies and management plans are published. A review of the conservation success of Trumpeter Swan (*Cygnus buccinator*) recovery over 50 years ago identified a model for future action to save other species: immediate threat abatement of direct mortality and habitat loss, education, fill knowledge gaps, increase number of locations, in-situ conservation and translocations to increase population, and habitat restoration (Denson 1970). Building on SARA's progress in developing processes and procedures for assessment, protection, and recovery planning, bridging the 'knowing-doing' gap (Pfeffer & Sutton 1999) to advance implementation is critical for achieving the purpose of SARA. Policies and planning are important, but species recover because of action.

2.4.3 PATHWAYS TO STOPPING EXTINCTION AND ACCELERATING RECOVERY

Halting extinctions and accelerating the recovery of threatened species is urgently needed to address the current biodiversity crisis. Implementation of the goals and targets of the KMGBF and Canada's 2030 Biodiversity Strategy provides an opportunity for the transformation of biodiversity conservation in Canada and around the world. The KMGBF recognizes the extinction crisis and Goal A provides a target on extinction and recovery: '*Human induced extinction of known threatened species is halted, and, by 2050, extinction rate and risk of all species are reduced tenfold and the abundance of native wild species is increased to healthy and resilient levels*' (CBD 2022a). Stopping extinction, reducing extinction risk, and recovery of wildlife will be critical to fulfilling Canada's international and domestic biodiversity commitments and the original intent of SARA.

Supporting species at risk recovery will require new approaches in Canada (Kraus et al. 2021; Turcotte et al. 2021). Our research shows that species continue to disappear from Canada and while we identify historic and contemporary species recoveries, these remain as the minority and most species listed under SARA fail to improve in conservation status (ECCC 2023a). Canada's final national report for the CBD on 2020 Biodiversity Goals and Targets (Government of Canada 2018) identified threatened species as one of three targets that were not even partially met (in addition to water pollution and sustainable marine harvests), highlighting the need for transformative approaches for endangered species conservation. To support domestic implementation, we have identified five pathways based on the results of our study to establish quantifiable species targets around extinction and recovery and support a national action plan to halt and reverse the loss of wildlife.

Extinction and recovery accounting

Our study was sparked by the knowledge gap on the numbers and characteristics of species loss and recovery in Canada. The results identify species where conservation actions have reduced extinction risk. Critically they also illustrate that despite laws, policies, and actions to protect endangered species, there is no evidence the loss of wildlife is slowing, and few species are recovering. While this research is a snapshot, it highlights the need for improved and regular national extinction and recovery accounting.

A national ledger of extinction and recovery is critical for adaptive management, knowledge mobilization, to monitor progress, and inform and inspire future recovery efforts. Fortunately, many of the pieces to initiate and improve extinction and recovery accounting are in place. Building on our efforts with NatureServe Canada to curate data on extinct, extirpated, and historical species, this data can continue to be updated and used for future reporting on ‘missing’ species. This would complement reporting on Goal A of the KMGBF.

Reporting on changes in the status of wildlife species at risk can be enhanced by applying our approach. Canada’s current reporting shows that 20% (105/530) of species that have been reassessed by COSEWIC are now in a lower risk category (ECCC 2023a) and an analysis a decade earlier identified that 14% (52/369) of species had improved in conservation status (Favaro et al. 2014). However, as we demonstrate, few of these have improved because of conservation actions and the rate of genuine recovery as of 2022 is 9.9% (49/492). Incorporating the reason for status change, using the codes we applied for this study (**Table 12**) could help to improve the transparency of reporting on species at risk status change and better inform future recovery actions. While not included in our analysis, ‘up listings’ (i.e., from a lower to higher risk category) appear to be primarily ‘genuine’ and are the result of an increase in threats or decline in number of locations or populations. More detailed analysis on why species are uplisted could be a future extension of our research and defining categories for uplisting would support recovery accounting. While our analysis was based on categories used by the IUCN Red List, a more detailed analysis could retrospectively apply the IUCN taxonomy of conservation actions (Salafsky et al. 2008) and link these to the historical threats that were mitigated.

Extinction and recovery accounting that builds on our results can also be used by COSEWIC to better understand which species are more likely to change status after assessment because of new information and to consider delays in assessments until additional field studies are conducted. This will require greater funding for species assessments, but these costs will be offset by reducing the number of non-genuine status changes and, in some cases, the costs of assessing and listing species that are not at risk.

We recommend that COSEWIC assessments identify if changes in status upon reassessment represent a genuine or non-genuine change and link the change to the reasons we outlined in **Table 12**. Consistency in describing and categorizing status changes as genuine or non-genuine would also increase the transparency of reassessments. For example, while the ‘COSEWIC reason for designation’ on the SARA registry for status change of the Shorthead Sculpin (*Cottus confusus*) is very clear (i.e., “A change from Threatened (2001) to Special Concern reflects an increase (to 13) in the estimated number of locations.”), rationale for the status change of many other species are less transparent (e.g., Spiked Saxifrage [*Micranthes spicata*]). The Committee on the Status of Species at Risk in Ontario (the provincial equivalent of COSEWIC) has started to identify if status changes are genuine or non-genuine and this approach could be further developed (see: <http://cossaroagency.ca/species/>). Status change categories are included in general status reporting (Canadian Endangered Species Conservation Council [CESCC] 2022), although genuine and non-genuine status changes are not explicitly tracked or applied to all species. Adopting the reasons we outlined in **Table 12** for general status reporting could also help to improve our understanding on trends of threatened species in Canada.

In addition we recommend that COSEWIC consider global guidance from the Red List (IUCN 2019c) and develop approaches to apply the tags of 'possibly extinct' and 'possibly extinct in the wild' (and 'possibly extirpated' and 'possibly extirpated in the wild') for species assessed as endangered that are likely to already be extinct or extirpated but for which confirmation is required. This would highlight species where additional surveys are needed and initiate a process for declaring a species as extirpated or extinct.

Build the biodiversity baseline

Non-genuine recoveries are a symptom of the paucity of biodiversity information in Canada. As we identified, the economic costs of 'recovery by discovery' are significant, and these funds would be better directed at baseline inventories, particularly for cryptic and poorly studied species. Increased funding and support for Conservation Data Centres, Biological Survey of Canada, museums, and other biodiversity institutions is needed to fill significant gaps in our understanding of the diversity, distribution, and conservation status of Canada's wildlife.

In addition, increased funding for preparing COSEWIC assessments, particularly for data-poor species, would ensure a more comprehensive baseline for assessments and recovery documents. There are often insufficient funds to revisit historical locations or inventory potential new locations. Investing in inventories could avoid future costs of status changes resulting from non-genuine recoveries. For some species, contracts for inventories could be separated from the assessment. This would provide an opportunity to review the inventory data and to assess the probability of undocumented occurrences, and to determine if more information is needed before the assessment proceeds. Habitat suitability models are proving to be useful in locating additional populations of rare species in Canada, and should also be considered as part of the inventory and pre-assessment screening for data-poor and cryptic species (McCune 2019; Rosner-Katz et al. 2020). Systematic surveys by experts are critical for species assessments but are chronically under-resourced and limited in geographic scale (Hochachka et al. 2012). This restricts the application of expert utility of observations in estimating species distributions for many taxa (Meyer et al. 2016).

In addition to a more detailed assessment of undetected occurrences and increased field surveys, revisiting the current guidelines on data deficient species is warranted. While COSEWIC is reluctant to apply data deficient (because in the past species assessed as data deficient were often never reassessed), the prevalence of non-genuine recoveries demonstrates the utility of revamping this risk category. Funding and a clear reassessment timeline for data deficient species should accompany this updated guidance.

Community science can help to build Canada's biodiversity baseline while fostering conservation engagement and greater environmental citizenship (Jørgensen & Jørgensen 2021). Community science can be a significant and important source of biodiversity information (Andrews et al. 2019; Brown & Williams 2019) and could be harnessed in Canada to support inventories prior to species assessments. Particularly given the small budgets for species assessments, engaging in community science could support the collection of range and population information that could reduce the future number of non-genuine recoveries. Leveraging COSEWIC candidate lists as a 'call to action' for new data through iNaturalist and eBird projects could help to shift interest in these species with the public and naturalist community to the pre-assessment stage, rather than after they have been listed under SARA. Publicizing lists of 'missing' or 'most wanted' species can be a way to build public awareness of extinction, but also to encourage community science through a challenge to find these species (see section on engagement).

Report on recovery & renew ReNEW

During our review of species assessments, we found that ongoing recovery actions and progress were often absent or buried and difficult to ascertain. Factors of success are rarely described, and the narrative tends to focus on continued threats. COSEWIC reassessments ignore recovery targets and progress towards population and distribution objectives that have been developed for recovery documents, creating a disconnect between reporting on status reassessment and recovery. There even appears to be a slight reluctance in COSEWIC reassessments to identify (and even celebrate) conservation success and to downlist species.

There is certainly a paradox of progress in species recovery. Downlisting or removing a species from SARA reduces eligibility for funding which could impact conservation actions that the species needs for continued recovery or it could remove protections that are needed for the survival of the species. This balance between recovery and reduced legal protections should be addressed in species reassessments where status has improved. In some cases, despite improved status, removal of protections under SARA could risk survival. In others, there may be complementary legislation or actions such as habitat protection or stewardship that have successfully mitigated threats that should be recognized as conservation success through improvement in species status. For example, the reassessment of Dwarf Lake Iris (*Iris lacustris*) that downlisted the species from threatened to special concern downplays the role of new protected areas and other conservation actions in helping to conserve this species. The summary of the status change of the Lake Erie Watersnake (*Nerodia sipedon insularum*) from endangered to special concern focuses on continued threats. This communication on the improvement of status contrasts with the US where delisting of this species from the *Endangered Species Act* recognizes that “*Protection from direct killing and measures to prevent habitat loss helped Lake Erie watersnake numbers rebound. Public outreach played a key role in the snake's rapid recovery*” (US Fish & Wildlife Service 2011). Adding a section to species reassessments that are linked to recovery documents and more fully accounts for recovery actions and progress was not needed in the past, but as more recovery planning and actions occur, these need to be recognized and described.

Regular reporting on recovery would increase knowledge mobilization. Recovery stories in Canada are often shared as case studies or species-specific reports on recovery document implementation rather than a regular comprehensive review. Reporting on recovery documents and action plans is included in SARA (s. 46, 55, 72), but the multi-agency delivery has resulted in inconsistency. While Parks Canada regularly reports on recovery progress, and DFO has been increasing recovery reporting for aquatic species, CWS has only reported on recovery plan implementation for Caribou (*Rangifer tarandus*), Boreal Population (ECCC 2024b). In addition to regular reporting, a summary report on recovery progress would support information sharing among practitioners and the public. The annual reporting previously done by the Recovery of Nationally Endangered Wildlife (ReNEW) program could be reinvigorated to fill this role and support periodic implementation reviews completed by agencies (e.g. ECCC, 2018a).

An evidence repository of the factors of success (and failure) in recovery could also inspire and inform practitioners and ensure we are building on our collective knowledge (Sutherland et al. 2020). Systematic reviews and evidence reporting are widely used in the medical field and could help to reduce the science-practice divide in conservation (Walsh et al. 2019). Recent reviews on captive breeding and translocations for freshwater species at risk (Lamothe & Drake 2019; Lamothe et al. 2019; Rytwinski et al. 2021) could serve as a model for approaching and reporting on specific technical barriers to recovery.

Actions to accelerate recovery

This study can be used to inform future conservation actions and identify new approaches to halt and reverse the loss of wild species, including Canada's 2030 Biodiversity Strategy. In particular, our results show the importance of focused mitigation of key threats, the impact of translocations, and the growing role of protected areas and stewardship in species at risk recovery.

Most species that have recovered in Canada for genuine reasons are widespread species that were rapidly declining and recovered as the result of harvest regulation and traditional wildlife conservation in North America is largely built on this model of game management (Organ et al. 2012). Conservation actions, including threat abatement combined with bolstering and augmenting small and declining populations, have been very effective for many birds and mammals. Over the last few decades, the importance of keeping common species common has become more centralized in conservation (Gaston 2010). The concept of preventing wildlife declines was incorporated into the IUCN Red List in 2001 with the introduction of Criteria A (rapid declines) so that early interventions can prevent declining species from becoming rare (IUCN Species Survival Commission 2001). As a result, there are many species at risk in Canada that are still abundant and widespread, but rapidly declining, or projected to rapidly decline because of threats including invasive species and habitat loss.

However, most of the species we have lost from Canada were not widespread and declining but had small ranges and populations. Unlike past declines of birds and mammals that could be attributed to a few key threats, endangered vertebrate species in Canada now have an average of five listed threats (Currie & Marconi 2020), and we identified a total of 16 known threats that have caused the loss of species that range from climate change to problematic native species (**Figure 7**). Past conservation actions have largely mitigated the key threats of unsustainable harvest and some types of pollution, but habitat loss, invasive species, and climate change remain a threat for most species at risk. The lack of progress on these critical threats, the increasing number of threats, and novel threat combinations challenge traditional approaches to wildlife management and recovery.

Recovery strategies should directly respond to the criteria and risk factors identified during the assessment process. While threat mitigation efforts need to be prioritized for the greatest impact (Carwardine et al. 2019), very different timelines, approaches and even recovery documents templates are needed for recovering 'declining populations' and 'small populations' (Caughley 1994). Our results highlight that in general, species that are widespread but have rapidly declining populations take decades to recover, and this recovery often requires transformative changes in policy and values (the exception is marine fishes that are threatened by unsustainable harvest that can be quickly mitigated by regulation). Recovery of widespread, declining wildlife has proven to be possible, but they require sustained conservation efforts that must be national or regional in scale. Species that fall into this category today, such as Black Ash (*Fraxinus nigra*) and Monarch (*Danaus plexippus*), are very unlikely to fully recover in conservation status over the career of one conservation biologist. While protected and conserved areas may play a role, they will be insufficient for recovery. For threats such as climate change, invasive species, and pollution, species declines will continue even within protected areas (Cooke et al. 2023). Widespread and declining species require institutional change, and continued capacity and resources to sustain actions. Recovery documents need to account for the long-game and the intergenerational conservation that will be needed for these species.

Species with small ranges, low numbers, and narrow habitat specificity are the most vulnerable to changes in land use (Sykes et al. 2020) and stochastic events (Smith & Almeida 2019) and ultimately to extinction (Staude et al. 2020). While there is urgency, there can also be an opportunity to improve conservation status more quickly. These are also the species where Emergency Orders issued under SARA to stop imminent threats, and targeted funding can be critical to halting extinction or extirpation

and rapidly advancing recovery. SARA provides the authority to intervene on non-federal lands when it becomes apparent that individuals of a species, their residences or critical habitat are not otherwise protected. The federal government has used these backstop authorities very sparingly in the past 20 years – only three emergency orders have ever been made. Almost 90% of Canada’s missing species were rare and restricted species and provinces and territories had a critical role in halting these extinctions. These species often also co-occur on the landscape, such as Garry Oak ecosystems in BC and tallgrass prairies in Ontario and Manitoba, and multi-species habitat-based approaches to recovery can be applied. Species such as Pink Sand-verbena (*Abronia umbellata*) and Sage Thrasher (*Oreoscoptes montanus*) can be recovered within a generation, and these actions can often happen at a local scale and be championed by small groups of dedicated people.

We identified that almost 20% of genuine recoveries occurred under a decade because of rapid threat abatement. Opportunities for ‘rapid recovery’ should be identified be the focus of the most urgent intragenerational conservation actions including translocations and protected areas, as discussed below. However, a process to preemptively implement ‘rapid recovery’ actions before threatened species are assessed and listed under SARA should receive greater consideration.

Species translocations have supported the recovery of many species in Canada. In a review of 541 SARA-listed species, translocation had occurred for 55 species. In addition, 49 were recommended for translocation, and 99 were under consideration (Swan et al. 2018). While there are currently efforts to accelerate translocations of several species, including freshwater fishes in the Great Lakes region (Lamothe & Drake 2019), translocation has only contributed to the improved conservation status of eight birds, mammals, and fishes in Canada. Translocations have been complicated in Canada because recent changes to the COSEWIC approaches to the delineation of DUs invalidate the use of translocations across DU boundaries. As a result, successful reintroduction efforts of the Striped Bass (*Morone saxatilis*) St. Lawrence River population, first assessed as repatriation of an extirpated species, is now assessed as extinct because the translocation source was from another population. Translocations are clearly required to return most extirpated species to Canada, and this has been successful for a small number of species (e.g., Swift Fox [*Vulpes velox*], Wild Turkey [*Meleagris gallopavo*]). However, most recovery strategies for extirpated species have concluded that recovery is not feasible, despite examples within the US, such as the Greater Prairie Chicken (*Tympanuchus cupido*) (Johnson et al. 2011). Particularly for species that are globally imperiled, increasing the size and number of populations is an important conservation strategy. While not widely adopted in Canada, species at risk translocations will play a critical role in increasing populations and number of locations, and in most cases will need to be done in concert with habitat protection, restoration, and stewardship. Translocations between DUs and subsequent reassessment requires a re-examination to enable the success and reporting of meeting species population and distributions objectives.

Today, most species are no longer threatened by unsustainable extractive harvest, and future recovery will need to be driven by habitat protection and stewardship. Habitat protection and stewardship has not played a major role in the recovery of species (**Table 15**), however, there are a growing number of examples where these actions are resulting in relatively rapid and genuine recovery. Protected and conserved areas are critical for species at risk in Canada, and many species would be at higher risk if they did not occur within protected areas. There are a few examples of new protected and conserved areas are a contributing factor to improved conservation status (e.g., Rocky Mountain Tailed Frog [*Ascaphus montanus*], Lyall's Mariposa Lily [*Calochortus lyallii*]). Protected areas have been shown to be effective in reducing extinction risk (Butchart et al. 2012). As Canada works to achieve the target of protecting 30% of lands and waters by 2030, a greater focus on protected and conserved areas that include overlapping critical habitat for multiple species at risk, particularly those with small ranges, would support recovery progress over the next decade.

Stewardship is a central principle of SARA and the focus of funding through the federal Habitat Stewardship Program. While stewardship has been instrumental in preventing the decline of many species, there are few examples where stewardship resulted in delisting or downlisting. However, as with protected and conserved areas there are a growing number of examples, with the Western Blue Flag (*Iris missouriensis*) as one of the best-case studies on successful stewardship-based recovery on the private land base. Many at-risk species co-occur in specific geographies and habitats in Canada, and focused habitat protection and stewardship can result in the recovery of several species.

Wildlife recovery of the future must simultaneously conserve species with small populations and ranges while addressing pervasive threats that are driving wildlife declines. Many Canadian species that are currently at risk will not recover without additional habitat protections and stewardship and will remain in the same risk category if there is no increase in the number of locations or the population size. Increasing population and restoring range is necessary to reduce threats and will also directly respond to assessment criteria. Halting decline is important and a critical first step in wildlife conservation, but maintaining the status quo is not species recovery.

Build engagement and public awareness about the biodiversity crisis & recovery opportunities in Canada

Finally, we hope that these results can be used to engage the public and decision-makers on the state of wildlife in Canada and to inspire action. Despite our current extinction crisis, Canada has a long history of recovering wildlife species. It is critical to build public awareness about extinction, but it is equally important to showcase the solutions to species recovery within the public, scientific, and conservation communities. As demonstrated from media coverage of the reintroduction of Plains Bison (*Bison bison bison*) to Banff National Park or the return of the Bald Eagle (*Haliaeetus leucocephalus*) to the City of Toronto the public is interested in stories of recovery. Stories of hope can also increase conservation engagement (Dean & Wilson 2022; McAfee et al. 2019). Our ability to recover species needs to be shared and celebrated and we need to demonstrate solutions.

We also hope that our list of ‘missing’ species will encourage researchers and naturalists to search for species with historical occurrences. Extinction and ‘missing species’ stories have engaged the public in understanding the biodiversity crisis and the erosion of wildlife diversity. Public engagement could include reports on species that have disappeared (e.g., Bjorhus & Hargarten 2022) and stories on “most wanted” missing species (e.g., www.rewild.org/lost-species/top-25-most-wanted-lost-species). These extinction stories can be leveraged to build awareness about species loss and our opportunity to prevent other species from disappearing.

2.5 CONCLUSION

Reporting on wildlife extinction and recovery in Canada is an important element of conservation and tracking our domestic and global efforts to reach the goals and targets for the Global Biodiversity Framework. These results will help to support the first two stated purposes of SARA (s.6) on wildlife species extinction and extirpation and wildlife species recovery. Our reporting also provides a baseline to measure future extinction and recovery trends, and most importantly, can help to guide actions to improve our collective response to the biodiversity crisis. We hope that our results can inform and inspire ambitious species conservation goals and contribute transformative approaches to species at risk recovery, and help to transition species at risk conservation from a ‘defense game focused on preventing the progression of extinction’ (McLellan et al. 2023) to proactive recovery that results in healthy wildlife populations and habitats.

The ambition and effectiveness of our collective conservation responses are not yet keeping pace with the magnitude of the biodiversity crisis. Urgent actions are needed to build public support in halting and reversing the extinction crisis and empowering the people and institutions that are championing these efforts. It is just as important to create awareness about species recovery within the public, scientific and conservation communities. Canada's missing and recovered species provide an opportunity to build on best practices, inspire action, showcase the benefits of species recovery, and allow us to reimagine our relationship with wildlife.

Supplementary information for this chapter can be found at this [link](#).

CHAPTER 3. PRIORITIZING NATIONALLY ENDEMIC SPECIES FOR CONSERVATION

This chapter was published in Conservation Science & Practice:

Kraus, D., Enns, A., Hebb, A., Murphy, S., Drake, D. A. R., & Bennett, B. (2023). Prioritizing nationally endemic species for conservation. *Conservation Science and Practice*, 5(1), e12845.

<https://doi.org/10.1111/csp2.12845>

Text formatting and style reflects the requirements of the journal.

In addition, I co-authored this article on nationally endemic lichens that was based on the data for the paper:

McMullin, R. T., & **Kraus, D.** (2021). Canada's Endemic Lichens and Allied Fungi. *Evansia*, 38(4), 159-173, 115. <https://doi.org/10.1639/0747-9859-38.4.159>

Funding to NatureServe Canada was provided by the Echo Foundation, Langar Foundation, and McLean Foundation. The following experts across Canada kindly contributed their time and knowledge to support the project: Robert Anderson, Wasyl Bakowsky, Aaron Bell, René Belland, Joe Bennett, Rob Bennett, David Blades, Adam Burke, Syd Cannings, Suzanne Carriere, Paul Catling, Lars Crabo, Simon Dodsworth, Hume Douglas, Dan Farr, Justin Fulkerson, Lea Gelling, Daniel Gibson, Trevor Goward, Jamie Grimm, Crispin Guppy, Nancy Hébert, Patrick Henry, Rob Higgins, Virginia Hudson, Colin Jones, Jeff Keith, Joel Kits, John Klymko, Samantha Knight, Jacques Labrecque, Dwayne Lepitzki, Christie Macdonald, Nick Mandrak, John D. McPhail, Arne Mooers, Randi Mulder, Ryan Norris, Josh Noseworthy, Mike Oldham, Greg Pohl, Andrew K. Rasmussen, Justina Ray, John Riley, Michael Rudy, Cory Sheffield, and Don Sutherland. Janet Scott (IUCN Red List Unit) and Fabiana Lopes Rocha (IUCN SSC Center for Species Survival Brazil) kindly provided global context on nationally endemic species.

Abstract

Over 90% of recent human-caused extinctions are wild species known from only one nation. These nationally endemic species represent one of the greatest global conservation responsibilities for any country. To meet this responsibility, we must first identify nationally endemic species. We developed the first comprehensive inventory of the 308 plant, animal, and fungi species and infraspecies only found in Canada, of which approximately 90% are of global conservation concern. Our analysis also identified 27 spatial concentrations of endemic species, many of which are associated with glacial refugia, islands, coasts, and unique habitats. Nationally endemic species have not been the primary focus of endangered species conservation in Canada and other countries. Our analysis provides a case study on how national inventories of endemic species can be developed and applied to support species assessments and place-based conservation. Prioritizing endemic species for conservation can build on sentiments of sense of place and national responsibility to foster public interest. We propose a species conservation framework that highlights the critical role of national endemism in preventing global extinctions. Greater conservation focus on endemic species will support national and international biodiversity conservation targets, including the post-2020 Global Biodiversity Framework.

3.1 INTRODUCTION

The decline of wildlife is a global crisis with extinction rates up to one thousand times greater than historical levels and future rates that are projected to increase (De Vos et al. 2015; May & Lawton 1995). Globally, over 40,000 species are now assessed as threatened (IUCN 2022) and up to one million species are at risk of extinction in the coming decades (Díaz et al. 2019; Tollefson 2019).

There have been global efforts to list and recover endangered wildlife for over half a century starting with the first International Union for Conservation of Nature (IUCN) list of threatened species published in 1964 (Scott 1965; Vié et al. 2009). Preventing extinction is the goal of many global conservation efforts including the *Convention on Biological Diversity* (CBD) (Aichi Biodiversity Target 12) (UN 1992), the *United Nations Sustainable Development Goals* (Target 15.5) (UN 2018) and the draft post-2020 Global Biodiversity Framework (Target 4) (CBD 2022b).

Nationally endemic species (species that only occur within one country) have the greatest influence on rates of global extinctions. Many endemic species are characterized by a limited geographical range and/or small population size, which increases their vulnerability to extinction through stochastic events, direct anthropogenic threats, and increasingly by climate change (Cahill et al. 2013; Shaffer 1981). There are many examples of the vulnerability of narrow-range endemics, from the extinction of Macoun's shining moss (*Neomacounia nitida*) from eastern Ontario, Canada in the late 1800s (COSEWIC 2002) to the recent extinction of the Bramble Cay melomys (*Melomys rubicola*) in Australia (Waller et al. 2017).

Of the 938 extinct species and infraspecies (subspecies and varieties) on the IUCN Red List, 93.8% are nationally endemic (IUCN 2022). While 61% of species listed on the IUCN Red List as extinct were confined to islands (Matthews et al. 2020), a large proportion of global extinctions are also driven by the loss of nationally endemic species from continental nations. For example, in Canada over one-third of the species (excluding populations and designatable units) assessed as extinct by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) under the *Species at Risk Act* (SARA) are nationally endemic (Government of Canada 2022). The high proportion of extinct species that are nationally endemic is a result of both their greater extinction risk, and the ability to thoroughly survey their entire range to conclude they are extinct.

Nationally endemic species have been identified in some countries and regions, including the United States (Stein 2002), Russia (Griffin 1999), and Brazil (vertebrates) (Jenkins et al. 2015). The IUCN also reports on Red List threatened species that are nationally endemic (IUCN 2019b) and national endemism can be queried through some taxon databases (e.g., Beech et al. 2017). However, comprehensive inventories of nationally endemic species do not exist for most countries. Developing an inventory of nationally endemic species can be challenging because of limited survey and taxonomic capacity, different species concepts across taxa, and taxonomic classifications both within and adjacent to a particular country. But such an inventory is critical to inform conservation actions and stop global extinctions.

Canada is one of the countries that lacks a comprehensive inventory of endemic species. There have been studies that list a preliminary subset of endemic species, starting with centers of Canadian plant endemism that were identified in the 1970s (Kershaw 1976; Kershaw & Morton 1976; Mosquin & Suchal 1977). NatureServe Canada has reported on globally imperiled species in Canada that included some endemics (Cannings et al. 2005; Rainer et al. 2017). The most recent general status report on Canadian wildlife also identified a subset of national endemics but not subspecies and varieties (CESCC 2016).

In Canada, a comprehensive inventory of nationally endemic species will support COSEWIC wildlife assessments and potential listing under SARA (Kraus et al. 2021; Raymond et al. 2018; Turcotte et al.

2021). COSEWIC is an independent advisory panel to the Minister of Environment and Climate Change Canada that assesses the status of wildlife species at risk of extinction. The Minister decides if species assessed by COSEWIC as at-risk should be listed under SARA. One of the functions of COSEWIC is to ‘determine when wildlife species are to be assessed, with priority given to those **more likely to become extinct**’ [SARA, section 15 (1)(b), bold added]. To make this determination COSEWIC develops candidate lists of species almost two years before assessment. Higher priority species are identified based on apparent extinction risk, global conservation status, taxonomic distinctness, and the proportion of the global range in Canada. Candidate lists are developed by 10 taxon-based Species Specialist Subcommittees (SSCs). The approach to selecting candidate species is not standardized between SSCs, reflecting the differences in life histories, available information, and the number of species by taxonomic group (COSEWIC 2022). For example, there are currently 24 candidate amphibians compared to over 500 candidate vascular plants. Taxa groups with fewer species may include candidate species that are globally and nationally secure, as well as designatable units (geographically or genetically distinct populations). This contributes to the backlog of assessments of species that are potentially ‘more likely to become extinct’, including nationally endemic species.

Our paper explains how we developed the first comprehensive inventory of nationally endemic species in Canada (Enns et al. 2020) and explores why these species should be prioritized to advance national and global biodiversity targets. In this paper, we define ‘species’ as any wild plant, animals, or fungal species or infraspecies (subspecies, varieties, designatable units, and populations), which is consistent with the use of the term ‘wildlife species’ in Canada (Government of Canada 2002) and by the IUCN (IUCN 2022).

3.2 METHODS

A preliminary inventory of all North American species and infraspecies only recorded from Canada was prepared by querying NatureServe’s Biotics 5 (Central Biotics) (NatureServe 2018) database. This is the most comprehensive source of wildlife species in Canada. It includes species data from North America that are managed by provincial, territorial, and state Conservation Data Centres. Extinct and historical species were included so endemic species losses could be explored. Details on NatureServe’s methodology for assessing conservation status and data limitations are in the supplementary information (S.1).

We did not include hybrids, or populations and other designatable units identified by COSEWIC that are not subspecies or varieties (e.g., massasauga - Great Lakes / St. Lawrence population [Sistrurus catenatus pop. 1]) because their range outside of Canada is often not documented. All freshwater fishes included in Central Biotics as infraspecies were also excluded. There are inconsistencies in how freshwater fishes have been classified by COSEWIC and an ongoing taxonomic update will reassign some infraspecies to designatable units (Nick Mandrak, COSEWIC pers. comm. 2019). We used range maps available from COSEWIC to identify migratory animals that only breed in Canada and included these species as endemic. While not strictly nationally endemic, they are endemic to Canada during critical breeding and migration seasons. Species that only occur in the wild in Canada because they are extirpated from the US or part of reintroduction efforts but designated as experimental populations under the US *Endangered Species Act* were also included as Canadian endemics, although these species may occur as wild populations in the US in the future.

The preliminary inventory of nationally endemic species was refined by cross-checking the scientific names and synonyms with 10 global biodiversity databases to ensure they did not occur in the US and had not yet been entered in Central Biotics or occurred in countries not included in the database (e.g.,

Greenland). General internet searches using Google were made for all nationally endemic wildlife occurring near the US border to determine if there had been any recent records that were not included in the biodiversity databases we consulted. The draft inventory of nationally endemic species from Canada was then circulated to taxa and regional experts for final review.

Our final inventory of nationally endemic species along with status and range information from Central Biotics was prepared in an Excel spreadsheet and used to develop metrics on the numbers of nationally endemic species by taxonomic group, province and territory, and conservation status.

Species that are potentially endemic to Canada were also identified during the expert review. These species have very limited information on their range and have a high probability of also occurring in adjacent US states if targeted surveys were conducted. These are primarily arthropods only collected from a few locations in southern Canada and Yukon. These “potential endemics” were not included in our final inventory of national endemics.

We assembled spatial data on nationally endemic species from existing range maps and based on comments in Central Biotics or the literature. Point and polygon data were spatially joined to a 10²-kilometre grid overlaid across Canada. Any amount of intersection of a polygon with a grid was included. This 10²-kilometre grid scale is widely used for breeding bird atlases (North American Ornithological Atlas Committee (NORAC) 1990) and ensured the location of data-sensitive occurrences remained confidential. The individual grids were merged into one data layer, representing all species occurrences and unique fields were created by combining the 10²-kilometre grid with the scientific name. Data were summarized by unique fields to produce a count of occurrences of each species within each grid square. The resulting tables were further summarized by grid ID to generate the number of unique species per 10²-kilometre grid square. For the ecoregion level, the 10²-kilometre grid was intersected with ecoregions (ECCC 2019b) and the final count summarized.

Hotspots were based on the number of species within each 10²-kilometre grid. To determine initial sites, grid cells with three or more nationally endemic species were selected and reviewed. These initial sites were then expanded to include adjacent grid cells with one or more endemic species. Each site was then buffered by 5-km to create the boundary. Final boundaries were adjusted based on ecological features or expert review and names assigned based on place names and local features. The amount of protected and conserved area in each hotspot was calculated by overlaying Canadian Protected and Conserved Areas Database (last updated December 2020).

Summaries were prepared for each province and territory, by taxonomic group, and conservation status based on information in NatureServe’s Central Biotics. We considered species assessed by COSEWIC as endangered, threatened, or special concern to be at risk in Canada.

3.3 RESULTS

3.3.1 NATIONALLY ENDEMIC SPECIES IN CANADA

We identified 308 species found only in Canada. A full inventory of Canada’s nationally endemic species and their range and conservation status is included in the supplementary information (S.2).

Almost half of Canada’s endemic species in our study are invertebrates. Ten nationally endemic invertebrates have been assessed by COSEWIC and only half are ranked by NatureServe. The greatest number of nationally endemic invertebrates are dominated by better-studied groups such as moths, butterflies and skippers, and freshwater snails.

We identified 109 nationally endemic vascular plants in Canada. Only 12 nationally endemic vascular plants are ranked as globally secure. Twenty-three vascular plants have been assessed as at risk by COSEWIC. BC, Quebec, Yukon, Newfoundland and Labrador, and Saskatchewan have the highest numbers of nationally endemic flora.

Canada has 21 nationally endemic mammals. Over two-thirds of Canada's endemic mammals are of global conservation concern. Nine mammals have been assessed as at risk by COSEWIC. Two subspecies, Dawson caribou (*Rangifer tarandus dawsoni*) and Vancouver Island wolverine (*Gulo gulo vancouverensis*) are extinct or historical, although recent genetic analysis suggests Vancouver Island wolverine may not be a valid subspecies (Hessels et al. 2021). Eastern wolf once ranged into the northeastern US but is now restricted to a small and threatened population that centers on Algonquin Provincial Park in Ontario (COSEWIC 2015b; Heppenheim et al. 2018).

Canada has 14 mosses, liverworts, lichens, and fungi that are nationally endemic. All are of global conservation concern or are unranked by NatureServe. Only three of these have been assessed by COSEWIC, including the extinct Macoun's shining moss. This group occurs across the country, including a beard lichen (*Usnea fibrillosa*) endemic to Nova Scotia, slender notchwort (*Crossocalyx tenuis*) endemic to Ontario, and Carlott's wijkia moss (*Wijkia carlottae*) endemic to Haida Gwaii in BC.

Canada has 11 endemic birds, all of which are of global conservation concern based on NatureServe ranks, except for Harris's sparrow (*Zonotrichia querula*). However, this Arctic breeder has experienced population declines and has been assessed as special concern by COSEWIC (COSEWIC 2017a). Three other species have been assessed as at risk by COSEWIC (whooping crane [*Grus americana*], red crossbill *percna* subspecies [*Loxia curvirostra percna*], northern saw-whet owl *brooksi* subspecies [*Aegolius acadicus brooksi*]), and one species (Labrador duck [*Camptorhynchus labradorius*]) is extinct.

Four endemic fishes are identified in our analysis. Three species, Atlantic whitefish (*Coregonus huntsmani*), Vancouver lamprey (*Entosphenus macrostomus*) and copper redhorse (*Moxostoma hubbsi*), have been assessed as at risk nationally and are on the IUCN Red List of Threatened Species. The Banff longnose dace (*Rhinichthys cataractae smithi*) became extinct in the 1980s (Renaud & McAllister 1988).

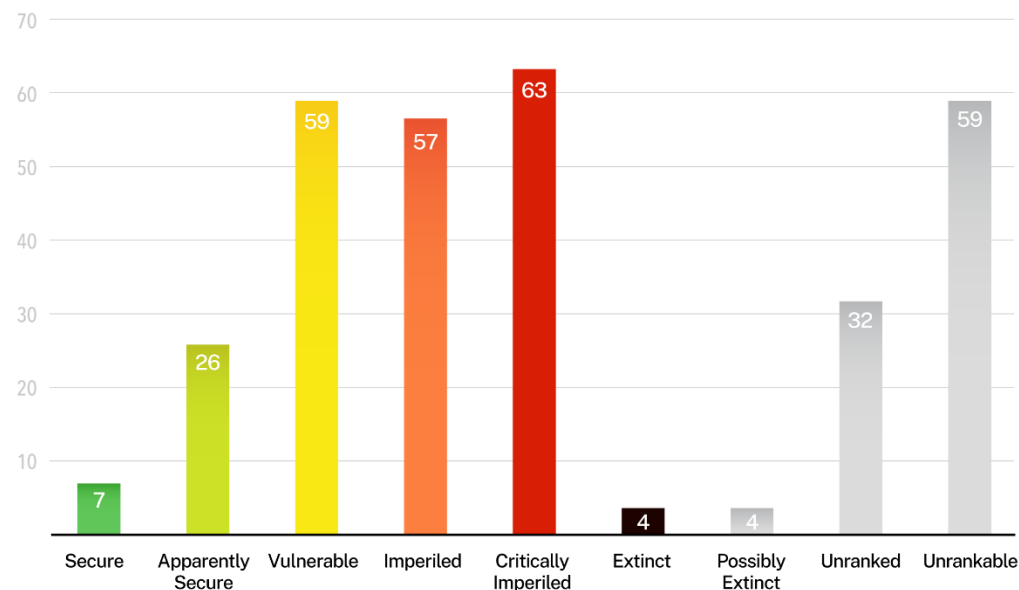
No endemic marine species were identified in our analysis. Unlike freshwater species, marine species occur in habitats that are typically continuous with other countries. There is also a lack of comprehensive surveys and marine species are under-represented in the Central Biotics database.

3.3.2 CONSERVATION STATUS OF NATIONALLY ENDEMIC SPECIES

Approximately 90% of Canada's nationally endemic species that have been assessed by NatureServe are of global conservation concern. Almost 40% have been ranked as critically imperiled (G1) or imperiled (G2) (**Figure 9**). This status reflects their limited global range and small populations. There is currently not enough information to rank almost one-third of Canadian endemics using NatureServe conservation status rank methodology. Less than 20% of Canada's endemic species have been assessed by COSEWIC. Another 28 species have been identified as candidates for future assessments (COSEWIC 2022). Only ten of Canada's endemic taxa are on the Red List (IUCN 2019b).

Eight of Canada's endemic species are now extinct or are known only from historical records. These represent 2.5% of all the endemic species documented in our inventory. Half of these losses have been from islands. Globally, endemic species restricted to islands represent more than 60% of known terrestrial extinctions in the last 500 years (Matthews et al. 2020). Two of the extinctions (Labrador duck and Dawson caribou) were driven by over-harvest and the remainder resulted from habitat loss or modifications for species that occurred in narrow ranges.

Figure 9: Global ranks of nationally endemic species in Canada



3.3.3 DISTRIBUTION & HOTSPOTS

Canada's endemic species are not evenly distributed geographically, with BC, Quebec, Alberta, and Yukon having the highest number (**Figure 10**). Approximately 60% of Canada's endemic species are restricted to a single province or territory. These subnational endemics can be found in all regions except for Prince Edward Island, with BC and Yukon having the highest numbers. Ecoregions with the most nationally endemic species include the Queen Charlotte Lowland (BC), Appalachians (QC), and Northern Peninsula (NL). This patchy distribution of endemism also occurs in the US (Jenkins et al. 2015) and throughout the world (Fa & Funk 2007).

Our study identified 27 spatial hotspots of nationally endemic species (**Figure 11**). They are generally associated with islands and coastal areas, although inland hotspots also occur and are typically sites with unique habitat conditions (e.g., Lake Athabasca sand dunes) and regions that served as glacial refugia (e.g., Beringia in Yukon). About half of Canada's hotspots of nationally endemic species are located in settled regions where ecosystems are dominated by human land uses (Kraus & Hebb 2020; Sanderson et al. 2002). Many of the northern hotspots are located in regions that are being impacted by climate change including rising temperatures (Porter et al. 2019) and increased rates of coastal erosion (Lantuit & Pollard 2008).

Figure 10: Total number of endemic species by province and territory

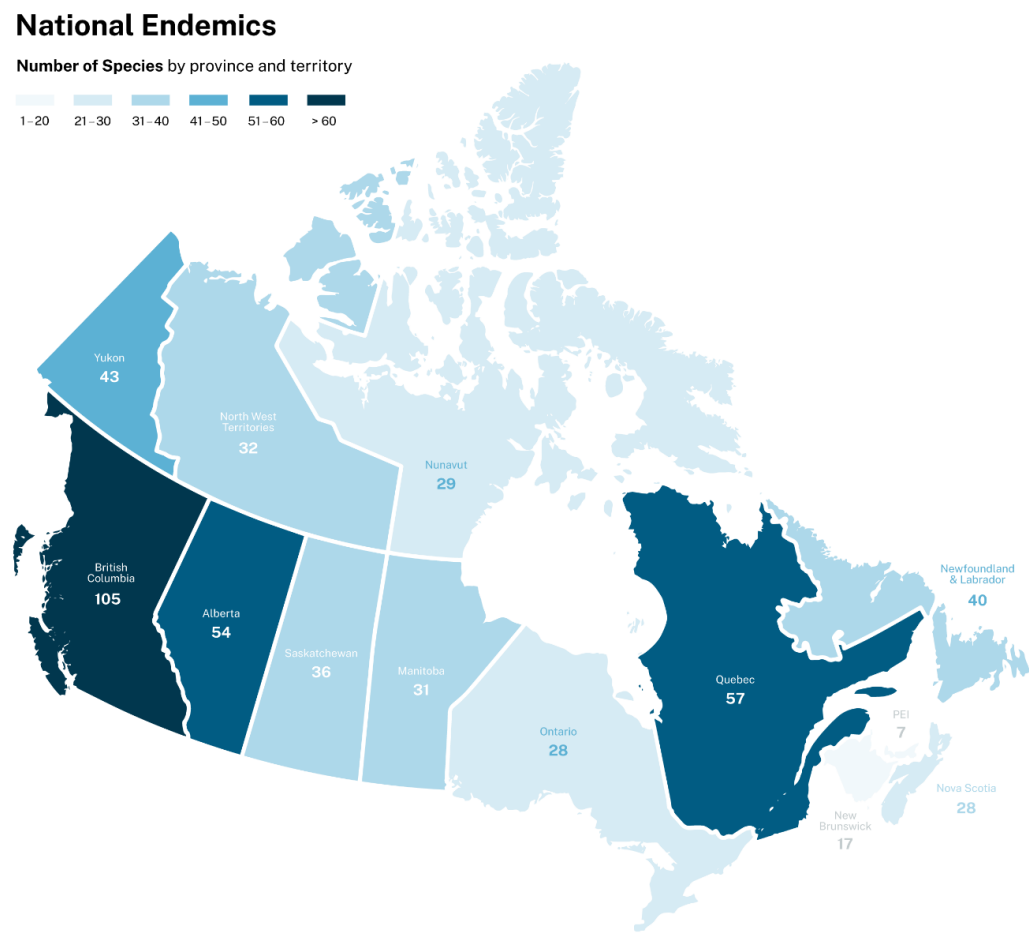


Figure 11: Hotspots of nationally endemic species

Hotspots of Endemic Species



Protected areas coverage is less than 20% for over half of these hotspots (**Table 19**). Sable Island, Banff, Jasper, and Waterton have over half of their area in National Parks and National Park Reserves. Other hotspots, including several in Canada's south, Arctic ecozone, and Newfoundland and Labrador include very few protected and conserved areas.

Table 19: Percent protected and conserved area within Canada's endemic species hotspots

National endemic wildlife hotspot	Percent protected¹
Sable Island	100%
Banff	88%
Waterton	63%
Jasper	61%
Haida Gwaii	48%
Ogilvie Mountains	48%
Kluane	45%
Sachs Harbour	42%
Gaspésie	32%
Hudson Bay Coast	32%
Lake Athabasca	20%
Cypress Hills	16%
Vancouver Island	16%
Mingan	14%
Avalon Peninsula	12%
Southwest Newfoundland	11%
Gulf of St. Lawrence	8%
Upper Bay of Fundy	8%
Mackenzie Delta	5%
Okanagan Similkameen	4%
Prince Edward Island North Shore	4%
St Lawrence River-Freshwater Estuary	4%
Central Yukon Plateau	2%
Great Northern Peninsula	1%
Kugluktuk	1%
Strait of Belle Isle	1%
Central Labrador Coast	0%

¹CPCAD as of December 31, 2020. Not including surrounding marine areas. Different mapping scales between protected area and terrestrial area boundaries may result in some discrepancies between the actual area protected.

3.4 DISCUSSION

Our study has generated Canada's most comprehensive inventory of nationally endemic species. We have highlighted the paucity of information available to assign conservation ranks to nationally endemic wildlife, particularly arthropods, the low proportion of nationally endemic wildlife that have been assessed by COSEWIC under Canada's SARA, and the hotspots with the greatest concentrations of nationally endemic species. Our results can be applied to fill key data gaps on endemic species, prioritize place-based conservation efforts, support species assessments and recovery, and engage the public in wildlife conservation.

3.4.1 FILLING KEY DATA GAPS ON CANADA'S ENDEMIC SPECIES

Almost one-third of Canadian endemic species have insufficient information to assign national NatureServe ranks or have continued taxonomic uncertainty. Further studies on their life history, distribution, population dynamics, evolution, genetics, systematics, and taxonomy are a high priority to provide sufficient data to conduct future national and global assessments. The NatureServe Canada Network of Conservation Data Centres, museums, and academic institutions are well positioned to fill this key information gap, but additional funding will be needed to accelerate these efforts. We also identified 167 species as potential endemics, with over 90% being arthropods. Continued investigation of these species is needed to refine their taxonomy, range, status, and Canada's conservation responsibility. Some of these species are probably restricted to Canada and once confirmed will be added to the national inventory of endemic species.

Many of the hotspots we identified have not been thoroughly surveyed. Areas with high concentrations of endemic species should be the focus of additional biological inventories, particularly for more cryptic taxa and with DNA barcoding (deWaard et al. 2019). The identified hotspots are typically the result of glacial refugia or physical and ecological conditions that drive speciation. Targeted inventories in Canada's endemic hotspots would provide additional information on known endemics and potentially discover new species.

Species, subspecies, and varieties are just one component of Canada's endemic biodiversity. Geographically or genetically distinct populations are also included in the SARA definition of wildlife species. Conservation of these distinct populations prevents local extinctions and maintains diversity within species (Des Roches et al. 2021) even if adaptive genetic variation has not been determined (Fernandez-Fournier et al. 2021). Some distinct populations such as the disjunct population of Blanding's turtle (*Emydoidea blandingii*) in Nova Scotia are restricted to Canada (Mockford et al. 2005). As geographically or genetically distinct populations are identified and confirmed to only occur in Canada, they should be considered in future iterations of Canada's inventory of endemic species. Distinct populations will continue to be discovered and defined as our understanding of population genetics for all species expands (e.g., Hendricks et al. 2019).

3.4.2 PRIORITIZING PLACE-BASED CONSERVATION

Canada has committed to protecting 30% of lands and oceans by 2030 (ECCC 2020a). Currently, 12.5% of Canadian lands and inland waters are conserved (ECCC 2021a), and meeting the new target will require the protection of over 1.7 million km². Conservation of endemic species hotspots can be incorporated into Canada's post-2020 targets to better focus on qualitative conservation measures (Lemieux et al. 2019).

Endemic species are important for the identification of Key Biodiversity Areas (KBAs). KBAs are nationally or globally important areas for species, ecosystems and biological processes identified through standard global criteria (IUCN 2016). Endemic species can be triggers for KBA criteria on threatened biodiversity (Criterion A), geographically restricted biodiversity (Criterion B), and irreplaceability (Criterion E). Our inventory of endemic species will help support the ongoing efforts of the Canadian KBA Coalition to identify important sites for biodiversity conservation. Recognizing and promoting the global importance of these sites is critical for the survival of threatened species and will encourage conservation action (Luther et al. 2021).

Many of Canada's endemic hotspots have not been the focus of species conservation efforts. Canada's hotspots for nationally endemic species are very different than spatial concentrations of species listed under SARA, which are primarily found along the southern border (Coristine et al. 2018, Figure 2). Federal, provincial, and territorial *Priority Places* for the conservation of species at risk currently excludes most of the key sites for nationally endemic species (ECCC 2018b). Endemic species hotspots offer a new place-based boundary to develop and implement actions plans to support the conservation of endemic species and other species of conservation concern. SARA requires the development of one or more action plans based on the recovery strategy for those species listed as endangered or threatened. To date, almost two-thirds of final action plans are for aquatic species and multi-species plans for national parks (Kraus et al. 2021) and endemic species hotspots offer a new and important geography to develop and implement action plans under SARA.

Many of Canada's nationally endemic species assemblages occur in unique and restricted vegetation communities. These include alvars and other rocky barrens, sand dunes, coastlines, hot springs, and alpine meadows. These extreme environments may drive speciation and the origin of new species (Harvey et al. 2020). More detailed mapping of these vegetation communities as a component of the broader initiative to complete the Canadian National Vegetation Classification system would support the identification and conservation of these rare and important habitat types and their species of conservation concern through ecosystem-based conservation initiatives.

3.4.3 SUPPORTING SPECIES ASSESSMENTS & RECOVERY

Our inventory of Canadian endemic species can be used to prioritize species for sub-national, national and global assessments, including by COSEWIC. Of the 183 nationally endemic species ranked by NatureServe as globally imperiled (G1, G2), vulnerable (G3) or possibly extinct (GH), less than one-third have been assessed by COSEWIC.

Jurisdictional responsibility based on the proportion of a species' global range within Canada is a key factor in prioritizing wildlife for national assessment (COSEWIC 2022); however, the majority of species listed under Canada's SARA are globally secure and occur at the northern edge of their range in Canada (Klemet-N'Guessan et al. 2019; Raymond et al. 2018) and most of Canada's nationally endemic species have not been assessed. Our paper improves the comprehensiveness of Canada endemics lists and in the short term, it is our hope that the list developed here will support existing SSCs in applying COSEWIC's current prioritization framework. However, prioritizing nationally endemic species may require a rebalancing of resources and capacity to the vascular plants and arthropod SSCs within COSEWIC to address the large number of species. Specialist subcommittees as described under SARA [section 18 (1)] are not restricted to taxonomic groups. An SSC focused on nationally endemic species could advance their assessment in cooperation with taxon based SSCs and support COSEWIC's function under SARA of prioritizing species that are more likely to become extinct.

To support species prioritization, we identified 56 high priority candidates for COSEWIC and IUCN Red List assessments (**Table 20**). These species are ranked as globally critically imperiled or imperiled (G1 or G2) but have not been assessed by COSEWIC or IUCN. We strongly encourage assessment of these high priority candidate endemic species but also call for immediate conservation action. Most of these high priority candidates have narrow ranges and can be targeted by conservation organizations, land trusts, and Indigenous communities for proactive conservation measures such as surveys, habitat protection, and public education.

Table 20: Priority endemic species for national and global species assessments and associated hotspots

Common Name	Scientific Name	Taxonomic Group ¹	Associated Hotspot
Sable Island cutworm moth	<i>Agrotis arenarius</i>	Arthropods	Sable Island
a geometrid moth	<i>Animomyia hardwicki</i>	Arthropods	NA
a centipede	<i>Arctogeophilus insularis</i>	Arthropods	Vancouver Island
Island Snow scorpionfly	<i>Boreus insulanus</i>	Arthropods	Vancouver Island
Lafontaine's tiger moth	<i>Chelis lafontainei</i>	Arthropods	Central Yukon Plateau
Johansen's sulphur	<i>Colias johanseni</i>	Arthropods	Kugluktuk
Rankin Inlet sulphur	<i>Colias rankinensis</i>	Arthropods	Hudson Bay Coast
a small scavenger beetle	<i>Hydnobius autumnalis</i>	Arthropods	NA
Yukon sweat bee	<i>Lasioglossum yukonae</i>	Arthropods	NA
a noctuid moth	<i>Lasionycta haida</i>	Arthropods	Haida Gwaii
a rove beetle	<i>Lypoglossa manitobae</i>	Arthropods	NA
Gaspésie grasshopper	<i>Melanoplus gaspensis</i>	Arthropods	Gaspésie
a rove beetle	<i>Mitosynum vockerathi</i>	Arthropods	NA
a millipede	<i>Nearctodesmus insularis</i>	Arthropods	NA
a ground beetle	<i>Nebria charlottae</i>	Arthropods	Haida Gwaii
a ground beetle	<i>Nebria louiseae</i>	Arthropods	Haida Gwaii
a leaf beetle	<i>Ophraella nuda</i>	Arthropods	NA
Sable Island borer	<i>Papaipema</i> sp. 6	Arthropods	Sable Island
constricted black fly	<i>Prosimulium constrictistylum</i>	Arthropods	NA
an amphipod	<i>Ramelligammarus vancouverensis</i>	Arthropods	Vancouver Island
Castleguard cave stygobromid	<i>Stygobromus canadensis</i>	Arthropods	NA
cordilleran stygobromid	<i>Stygobromus secundus</i>	Arthropods	NA
a geometrid moth	<i>Xanthorhoe clarkaeata</i>	Arthropods	Haida Gwaii
a lichen	<i>Myriolecis carlottiana</i>	Lichens	NA
Arctic orangebush lichen	<i>Seirophora aurantiaca</i>	Lichens	Sachs Harbour
a beard lichen	<i>Usnea fibrillosa</i>	Lichens	NA
Cypress Hills mountainsnail	<i>Oreohelix stantoni</i>	Molluscs	Cypress Hills
Newfoundland vallonina snail	<i>Vallonia terraenovae</i>	Molluscs	Southwest Newfoundland
Cain's screw moss	<i>Syntrichia cainii</i>	Mosses	NA
a moss	<i>Trematodon montanus</i>	Mosses	NA
Lake Louise arnica	<i>Arnica louiseana</i>	Vascular Plants	Banff, Jasper, Waterton
false northwestern moonwort	<i>Botrychium pseudopinnatum</i>	Vascular Plants	NA
Newfoundland chickweed	<i>Cerastium terrae-novae</i>	Vascular Plants	Great Northern Peninsula, Southwest Newfoundland, Strait of Belle Isle
elkwater hawthorn	<i>Crataegus aquacervensis</i>	Vascular Plants	Cypress Hills
dark green hawthorn	<i>Crataegus atrovirens</i>	Vascular Plants	Okanagan Similkameen
Enderby hawthorn	<i>Crataegus enderbyensis</i>	Vascular Plants	Cypress Hills
oval hawthorn	<i>Crataegus orbicularis</i>	Vascular Plants	Okanagan Similkameen
Adams Creek hawthorn	<i>Crataegus rivuloadamensis</i>	Vascular Plants	Cypress Hills
Battle Creek hawthorn	<i>Crataegus rivulopugnensis</i>	Vascular Plants	Cypress Hills
red bracteole hawthorn	<i>Crataegus rubibracteolata</i>	Vascular Plants	Cypress Hills
Shuswap hawthorn	<i>Crataegus shuswapensis</i>	Vascular Plants	Vancouver Island
slender notchwort	<i>Crossocalyx tenuis</i>	Vascular Plants	NA
Klaza draba	<i>Draba bruce-bennettii</i>	Vascular Plants	Kluane
Caswell's draba	<i>Draba caswellii</i>	Vascular Plants	NA
Cayouette's draba	<i>Draba cayouettei</i>	Vascular Plants	NA
Frankton's draba	<i>Draba franktonii</i>	Vascular Plants	NA
Kluane draba	<i>Draba kluanei</i>	Vascular Plants	Kluane
dense draba	<i>Draba pycnosperma</i>	Vascular Plants	Gaspésie, Great Northern Peninsula, Gulf of St. Lawrence, Strait of Belle Isle
Ojibway waterwort	<i>Elatine ojibwayensis</i>	Vascular Plants	NA
Sable Island eucosma	<i>Eucosma sableana</i>	Vascular Plants	Sable Island
Queen Charlotte Islands fescue	<i>Festuca pseudovivipara</i>	Vascular Plants	Haida Gwaii
Gaspé saxifrage	<i>Micranthes gaspensis</i>	Vascular Plants	Gaspésie
Lori's water-lily	<i>Nymphaea loriiana</i>	Vascular Plants	NA
Mackenzie River yellowcress	<i>Rorippa crystallina</i>	Vascular Plants	NA
seashore stitchwort	<i>Sabulina litorea</i>	Vascular Plants	Mingan
Gulf of St. Lawrence dandelion	<i>Taraxacum laurentianum</i>	Vascular Plants	Great Northern Peninsula, Mingan, Southwest Newfoundland, Strait of Belle Isle

¹ Taxonomic groups are based categories in Canada's Species at Risk public registry.

NA: Not associated with a hotspot. Spatial information linking these species and hotspots is based on a variety of data sources including Central Biotics and Global Biodiversity facility. Not all species have associated spatial information and additional priority endemic species may occur in the hotspots. See supplementary information for additional location information.

3.4.4 ENGAGING THE PUBLIC IN CONSERVATION

There is public interest in nationally endemic species. Media releases on the initial results of our study (Enns et al. 2020) resulted in articles by the Canadian Broadcasting Corporation, Canadian Geographic, and The Guardian. In total, over 800 interviews and articles resulted from the media release with circulation numbers of over 200 million. Subnational endemic species and hotspots were used to further regionalize our engagement and the connection between these species and the places where people live. Public engagement was supported by having a dedicated website for the project that provided a plain language summary of the findings and descriptions of endemic species from across Canada (<https://www.natureserve.org/canada/ours-to-save>). Regular updates to our inventory will be used as an opportunity for continued engagement in the future.

The concept of full conservation responsibility for nationally endemic species can be a powerful and convincing conservation message and appeal to ethical and patriotic moral foundations. There has been a higher level of public support for endemism over other conservation related species attributes (Meuser et al. 2009), even if the species is unfamiliar. Conservation messages about nationally endemic species can be used to build support and interest for other conservation issues and make the connection between local conservation action and global biodiversity conservation targets. Developing stories around endemic species and other species with high conservation responsibility that invoke patriotism, sense of place, legacy, and responsibility may be an under-utilized approach in conservation to engage a broader public.

3.4.5 A PROPOSED ‘ENDEMICS FIRST’ SPECIES CONSERVATION FRAMEWORK

Nature conservation should strive to conserve all wildlife. Our global efforts include many successes in recovering threatened species (Bolam et al. 2020), but have failed to stop the decline of wildlife and we are now standing at the threshold of the Sixth Extinction (Kolbert 2014; Pimm & Brooks 2000). National targets to halt and reverse the loss of all wildlife species should remain as a long-term aspiration, but these can be empowered by short-term objectives and quantifiable targets. We proposed a framework to help identify and guide species conservation actions that will support global biodiversity conservation goals to stop extinctions.

To better respond to the global biodiversity crisis, species of global conservation concern and high jurisdictional responsibility, including nationally endemic species, must be recognized and weighted more heavily in national assessment processes (Raymond et al. 2018; Turcotte et al. 2021).

While the importance of jurisdictional responsibility, endemic species, and species irreplaceability have been identified as priorities for conservation for over two decades (Gauthier et al. 2010; Margules & Pressey 2000; Myers et al. 2000; Schmeller et al. 2008) they are not yet clearly reflected in national prioritization exercises and conservation actions. The majority of threatened vascular plants in Europe are single-country endemics, but only 16% have Red List assessments (Holz et al. 2022). An Australian study found that only 6.8% of endemic plants, 9.4% of endemic birds and 28.9% of endemic mammals have been assessed under the *Environment Protection and Biodiversity Conservation Act 1999* (Alfonzetti et al. 2020). In Canada, the percentage of global range is one of the guidelines in prioritizing species, but it remains that over 80% of nationally endemic species have not been assessed for listing under SARA.

A framework to help clarify and focus national conservation actions and reporting on global priorities, including nationally endemic species, can support decision-making and resource-allocation on threatened species by governments and conservation organizations. Our framework is based on four

goals: 1) preventing global extinctions, 2) preventing national extinctions, 3) preventing species from becoming threatened, and 4) conserving all species (**Figure 12**).

The first goal is preventing global extinctions. Conservation of species that are nationally endemic and globally threatened with a large portion of their range or population within a country supports this goal.

While not all endemic species are at high risk of extinction, we identified that 90% of Canada's nationally endemic species assessed by NatureServe are of global conservation concern and there are 56 nationally endemic species that are a high priority for COSEWIC and IUCN Red List assessment. Many of these species are narrow endemics with a limited range and even those in protected or remote regions of Canada could be vulnerable to climate change and other global changes. Nationally endemic species should all be assessed because their conservation status directly impacts global extinctions. Although some species may be assessed by COSEWIC as special concern or even not at risk, this assessment, and resulting monitoring, will provide certainty to their actual extinction risk and flag species that require additional information.

Conservation of globally threatened species with high national responsibility also supports this goal. As with nationally endemic species, a country's action, or inaction, on these species will have a significant impact on their global status. Species that are assessed as globally threatened are already known to have some level of associated risk. (e.g., IUCN Red List or NatureServe). In addition to information on global status, range maps or population estimates and thresholds for determining high jurisdictional responsibility need to be developed for many taxa. Ecosystem-based automated range maps that are currently in development by NatureServe Canada will support the data gap in Canada. For nationally endemic and species with high jurisdictional responsibility, global status, range size, and taxonomic/evolutionary distinctiveness (Isaac et al. 2007; Redding et al. 2014; Redding & Mooers 2006) can be used to further prioritize assessments. Prioritizing nationally endemic and threatened species with high national responsibility would directly support Target 4 of the draft post-2020 Global Biodiversity Framework to prevent extinctions (CBD 2022b).

The second goal is preventing national extinctions beyond endemic species. This goal is already the focus of national species at risk legislation in Canada. National assessments by COSEWIC (endangered and threatened species) and NatureServe (critically imperiled and imperiled species) can be used to prioritize species to achieve this goal.

The goals of the last two groups in our proposed framework are to prevent species from becoming threatened (goal 3) and to maintain the full diversity of native species (goal 4). In Canada, goal 3 is already incorporated into SARA. Species assessed as 'special concern' are managed to prevent them from becoming endangered or threatened. Priorities within these groups include national status and species on national or global "watch-lists" or that are rapidly declining such as grassland birds (e.g., North American Bird Conservation Initiative 2016). With the exception of game and harvested species, common and generalist species often lack monitoring and conservation protections (Lindenmayer et al. 2011), but unless they are rapidly declining, these species are at a lower risk of extinction than rare and range restricted species.

Figure 12: Proposed species conservation framework



Our proposed framework provides a foundation to guide targets for threatened species conservation in the post-2020 Global Biodiversity Framework (B. A. Williams et al. 2020) and the IUCN Program Impact Framework for 2030 (IUCN 2021). The framework would support the Reverse the Red strategy by mobilizing local actions in response to global priorities (Rodríguez 2021) and could serve as the foundation of new national and global biodiversity targets that are based on extinction (Rounsevell et al. 2020). Halting the extinction of all nationally endemic species is a clear and quantifiable national biodiversity target that could be integrated into National Biodiversity Strategies and Action Plans. Based on the results of the 2020 Aichi Targets, these quantifiable targets are more likely to be achieved (Green et al. 2019). Similar targets could be developed for the other groups in our proposed framework. Many of these goals can be achieved concurrently through place-based conservation and actions to abate threats. We also hope this framework provides a reference to support conservation decision-making and rapidly clarify the contributions of species assessments and conservation actions to halting global extinctions.

3.5 CONCLUSION

Our study developed the first comprehensive inventory of Canadian endemic species. It is a dynamic inventory and will continue to be refined (e.g., McMullin & Kraus 2021) to support conservation efforts. The results have been incorporated into NatureServe's Biotics database and are available via data requests and through NatureServe Explorer and have been made available on a publicly accessible website. This inventory can be used to prioritize wildlife conservation actions and will support the identification of KBAs and the ambitious expansion of Canada's protected and conserved areas network over the next decade. As there are many gaps in our knowledge of these species, further research on endemic and potentially endemic wildlife is needed. Nationally endemic species can also be leveraged to inspire public support for wildlife and habitat protection.

Conserving nationally endemic species presents a critical path towards achieving global biodiversity targets. Nationally endemic species are each nation's sole responsibility to halt global biodiversity loss. The consequence of any country's failure to conserve endemic wildlife is a forgone opportunity to protect the Earth's biodiversity.

Supporting Information can be accessed at:

<https://conbio.onlinelibrary.wiley.com/doi/full/10.1111/csp2.12845>

S.1: Data limitations and NatureServe methodology for assessing conservation status

S.2 Canada endemic and potentially endemic species (XL)

Other information can be downloaded at:

<https://storymaps.arcgis.com/stories/23b1ba2f0e2e46ce9a8c27412f414fc1>

CHAPTER 4. TEN BRIDGES ON THE ROAD TO RECOVERING CANADA'S ENDANGERED SPECIES

This chapter was published in Facets:

Kraus, D., Murphy, S., & Armitage, D. (2021). Ten bridges on the road to recovering Canada's endangered species. *Facets*, 6, 1088-1127. doi:10.1139/facets-2020-0084

Text formatting and style reflects the requirements of the journal.

We would like to thank Andrew Drake (Department of Fisheries and Oceans) for sharing his thoughts and experiences in implementing the Species at Risk Act and his very helpful review of the manuscript, and to Dan McCarthy (University of Waterloo) for his valuable input on the design and review of an earlier draft. We are also very appreciative of the two anonymous reviewers for their very constructive feedback.

Abstract

Wildlife is declining around the world. Many developed nations have enacted legislation on endangered species protection and provided funding for wildlife recovery. Protecting endangered species is also supported by the public and judiciary. And yet, despite what appear as enabling conditions, wild species continue to decline. Our paper explores pathways to endangered species recovery by analyzing the barriers that have been identified in Canada, the US and Australia. We summarize these findings based on Canada's species at risk conservation cycle (assessment, protection, recovery planning, implementation, and monitoring and evaluation) and then identify ten "bridges" that could help overcome these barriers and bend our current trajectory of wildlife loss to recovery. These bridges include ecosystem approaches to recovery, building capacity for community co-governance, linking wildlife recovery to ecosystem services, and improving our storytelling about the loss and recovery of wildlife. The focus of our conclusions is the Canadian setting, but our findings can be applied in other national and subnational settings to reverse the decline of wildlife and halt extinction.

4.1 INTRODUCTION

The loss of wild species is a global issue (Barnosky et al. 2011; Ceballos et al. 2015; Pimm et al. 2014). Around the world many wild species that were once common are now declining (WWF 2020). Current extinction rates are up to one thousand times greater than natural historical levels (De Vos et al. 2015; May & Lawton 1995) and future rates are projected to increase. Globally, over 32,000 species are now assessed as threatened (IUCN 2022) and up to one million species are at risk of extinction in the coming decades (Díaz et al. 2019; Tollefson 2019).

For over half a century there have been global efforts to list and recover endangered wildlife. The first International Union for Conservation of Nature (IUCN) list of endangered species was published in the 1960s (Scott 1965). Conserving endangered species is now a target of global conservation efforts including the *Convention of Biological Diversity* (CBD) (Aichi Biodiversity Target 12) (UN, 1992) and the *United Nations Sustainable Development Goals* (Target 15.5) (UN, 2018).

Over 35 countries have national legislation to prevent the extinction of wild species (Mooers et al. 2010). These laws are generally supported by the courts (e.g. Langlois 2019) and by the public. Four in five Americans support the *Endangered Species Act* (Bruskotter et al. 2018) and almost 90% of Canadians agree that it is important to prevent extinctions (McCune et al. 2017). Legislation and action to recover endangered wildlife can be effective. In the US, listed under the *Endangered Species Act* (ESA) have fully recovered (Greenwald et al. 2019). Globally, conservation actions have prevented 21–32 bird and 7–16 mammal extinctions since 1993 (Bolam et al. 2020).

Despite some promising conditions, we may currently be witnessing the “sixth extinction” (Ceballos et al. 2015; Ceballos et al. 2017; Kolbert 2014; Pimm & Brooks 2000). Wild species continue to be lost, including in jurisdictions with strong endangered species legislation.

Our paper explores pathways to reimagine and improve endangered species recovery in Canada. We start by reviewing the approaches and effectiveness of endangered species conservation in Canada, Australia and the US. We then summarize the barriers to endangered species conservation that have been identified from these countries. The final section of our paper presents ten ‘bridges’ (Gunderson et al. 1995) that can support the transformation of endangered species management and change our current trajectory towards recovery.

4.2 THREE COUNTRIES, THREE ENDANGERED SPECIES ACTS, SAME RESULTS

We reviewed and compared the approaches, effectiveness and barriers of endangered species conservation of Canada with Australia and the US. We chose to review Australia and the US to find common issues and solutions that can be applied to endangered species conservation in Canada. These nations differ widely in their ecological setting, but share similar political and economic systems, histories of colonization, and national legislation to protect endangered species (**Table 21**). While the general framework of species assessment, listing and recovery is similar, there are unique approaches in each country.

4.2.1 CANADA

Canada has 80,000 known species and approximately 30,000 of those species have been assigned conservation status ranks by NatureServe (CESCC 2016). Due to its biogeography, Canada has fewer species than countries nearer the equator. This latitudinal gradient of species richness (Gaston 2000) also occurs within Canada, with more species occupying southern regions (Cameron & Hargreaves 2020). Most of Canada’s endangered species are found along the southern border (Coristine et al. 2018). These southern regions are also where most Canadians live and the natural systems have been heavily altered (Venter et al. 2016).

The *Species at Risk Act* (SARA) is part of Canada’s Biodiversity Strategy (Environment Canada 1995); the federal response after ratifying the United Nations *Convention on Biological Diversity* (CBA) in 1993. This international treaty made biodiversity a national interest. In Canada this federal interest in biodiversity protection is restricted by the constitutional division of powers (Campbell & Thomas 2002). The federal government has very limited jurisdiction in the provinces, and can only protect migratory birds, aquatic species, and species found on federal lands (e.g. national parks, national wildlife areas). All other species and geographies fall under the jurisdiction of the provinces. Federal responsibilities of SARA lie within three different departments. The Ministry of Environment and Climate Change (ECCC) is responsible for the overall coordination of the federal species at risk strategy and the protection and recovery of migratory birds. The Department of Fisheries and Oceans (DFO) is responsible for the protection and

recovery of aquatic species at risk under federal jurisdiction. Parks Canada Agency is responsible for the development of recovery strategies for those species that occur in Canada primarily in national parks, national historic sites and other federal protected heritage areas.

Canada's *Species at Risk Act* maintains a separation between species assessments and listing. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species (including subspecies, varieties or other designatable units) that are suspected of being at risk of extinction or extirpation. The government then decides if species assessed as at risk will be listed under SARA in a schedule. Once listed, the species receives legal protection afforded and mandatory recovery planning required under SARA.

There are 810 species that COSEWIC has assessed in risk categories and 688 species are listed under the *Species at Risk Act*. Canada currently has 41 species that have been assessed as extinct or extirpated (Government of Canada 2022). This does not include all species assessed as extinct on the IUCN Red List (e.g. Rocky Mountain Locust [*Melanoplus spretus*]) or extirpated by NatureServe (e.g. Pale Aves [*Geum virginianum*]) and the actual number is higher. Regardless of the number of species lost from Canada, species continue to disappear, such as the recent extinction of the Hadley Lake Stickleback (*Gasterosteus aculeatus*) pairs (Taylor & Piercey 2018).

Key threats to species at risk include habitat loss (agriculture and urban expansion), over-exploitation, invasive species and interactions with native species (Prugh et al. 2010; Venter et al. 2006; Woo-Durand et al. 2020). Human disturbance and invasive species are the most frequently listed threats in species recovery strategies (McCune et al. 2013). The threat of climate change and pollution are increasingly identified as threats to species at risk (Woo-Durand et al. 2020).

Federal, provincial and territorial ministers are responsible for implementing SARA and, with the exception of the province of Quebec, signed the non-binding *Accord for the Protection of Species at Risk* in 1996. The federal government can enforce SARA through emergency orders and the "safety net" provision, but these are rarely invoked. As such, a patchwork of protection measures exist for most species through differing provincial and territorial interpretations and implementation of SARA (Olive 2015). For example, many species listed under SARA are not included in provincial or territorial legislation (e.g. BC, see Westwood et al. 2019), which can limit recovery efforts. The incongruity is most pronounced in the six jurisdictions (Nunavut, Yukon, BC, Alberta, Saskatchewan, PEI) that do not have specific provincial or territorial endangered species legislation and manage species at risk under existing provincial acts (primarily *Wildlife Acts*).

There are several aspects of endangered species listing and recovery that are unique to Canada. SARA was influenced by the experiences of endangered species legislation in the US, and focuses on stewardship rather than regulation (Illical & Harrison 2007). Unlike the US and Australia, most endangered species in Canada are range edge species that are of national, but not necessarily global, conservation concern (Raymond et al. 2018). Canada also prioritizes and assesses species through taxon-based Species Specialist Subcommittees within COSEWIC and assesses more wildlife below the species level (i.e., ecologically and evolutionarily distinct sub-species or populations) as designatable units than Australia and the US. Currently 27% of the species assessed as at risk or extinct by COSEWIC are below the species level, including 25 designatable units of Sockeye Salmon (*Oncorhynchus nerka*) and 11 designatable units of Caribou (*Rangifer tarandus*).

Recovery planning in Canada is also unique. While in the US and Australia the scientific bodies that assess risk are involved in the approval of recovery plans, COSEWIC does not have this role in Canada (although individual COSEWIC members may provide input to recovery strategies).

In Canada, most species do not change risk status categories (Favaro et al. 2014). An almost equal percent have moved to a higher (17%; uplisting) or lower (18%; down-listing or delisting) category (ECCC 2022a) when reassessed (usually every ten years). However, there are issues in this classification approach since most of the down-listings are the result of the discovery of new populations or changes in criteria and species classification, rather than genuine recovery that result from increased populations or threat mitigation.

4.2.2 AUSTRALIA

Australia has been identified as a “mega-diverse country” (Mittermeier et al. 1997) with two global biodiversity hotspots along its eastern and southwestern coasts (Myers et al. 2000). Over 147,000 species have been documented, but the actual number is estimated to be over 566,000 (Chapman 2009). Because of Australia’s continental isolation, most species are nationally endemic. Invasive species, habitat loss and modification, altered fire regimes, and agricultural activities are impacting the greatest number of endangered species (Evans et al. 2011; Kearney et al. 2019). Unlike Canada and the continental US, the main contributing factor to extinction in Australia is predators introduced to islands (Woinarski et al. 2015).

In Australia, the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) is the main federal legislation to protect endangered species and, like Canada, was developed in response to the *Convention on Biological Diversity*. Species are prioritized and assessed by the Threatened Species Scientific Committee (TSSC). The TSSC reviews a nomination list annually and provides independent scientific advice to the Minister for the Environment on the proposed listing status and on the approval of recovery plans.

The EPBC Act has much broader scope than SARA and covers several matters of national environmental significance including threatened ecological communities (Government of Australia 2019). As with species, recovery plans are prepared for listed communities. In addition, key threatening processes can also be assessed and listed. Key threatening processes are those that are endangering, or could endanger, threatened species and communities. There are currently 21 key threatening processes that are listed, which include predation by feral cats, land clearance, and incidental catch of seabirds. However, the government has recently stopped listing threats under the EPBC Act (Cox 2020). Changes to endangered species legislation to reduce protection under the auspices of efficiency and removal of “red tape” is a common and reoccurring event that has also recently occurred in the US (Lambert 2019) and Ontario, Canada (Bergman et al. 2020).

In 2015, the federal government released the *Threatened Species Strategy* to accelerate the recovery of wild species (Government of Australia 2015). The strategy prioritized efforts and partnerships with local communities and state/ territory governments over a five-year period and set specific recovery targets.

Australia has experienced the largest documented decline in biodiversity of any continent over the past 200 years (Australian Bureau of Statistics 2020). It has one of the highest human-driven extinction rates of land mammals (Woinarski et al. 2015), with continued loss of potential critical habitat for threatened species and communities (Ward et al. 2019). Recovery plans do not have a significant effect on species conservation status (Bottrill et al. 2011). A recent study concluded that since Australia's EPBC Act was

enacted, four times as many vulnerable species have declined in their threat status than have improved (Simmonds et al. 2019). This is likely the result of both delayed ecological responses to conservation actions (Watts et al. 2020) and ineffective approaches.

4.2.3 UNITED STATES

The US has also been identified as a “mega-diverse country” (Mittermeier et al. 1997) with a high richness of endemic freshwater fishes and mussels, turtles, and salamanders (Stein et al. 2000). The California Floristic Province, Polynesia-Micronesia (including Hawaii) and the North American Coastal Plain have been identified as biodiversity hotspots (Myers et al. 2000; Noss et al. 2015) and most endangered species occur in these regions (Dobson et al. 1997). There are an estimated 200,000 species in the US and one-third of these are of conservation concern (Stein et al. 2000). Primary threats to endangered species are habitat loss, invasive species and pollution (Evans et al. 2016; Wilcove et al. 1998). These threats, along with climate change, have generally been increasing over time (Leu et al. 2019).

The *Endangered Species Act* (1973) is among the world’s first national endangered species legislation. The US Fish and Wildlife Service leads the process of species nomination, assessment, listing and recovery planning. The most important factors for listing species under the ESA are the magnitude and immediacy of threats and taxonomic distinctiveness (USFWS, 2016b). Although there is coordination between the federal and state governments through *State Wildlife Action Plans*, most states have not enacted complementary legislation and provide little funding to the management and recovery of endangered species (Camacho et al. 2017).

There are notable differences between the US and Canadian approaches to listing and recovery (Olive 2014a, 2014b, 2016; Pawluk et al. 2019). ESA assessment criteria focus on threats and the effectiveness of existing protections, but do not include intrinsic factors that increase extinction risk (e.g. small populations) (USFWS, 2016b). In the US “distinct population segments” can only be applied to vertebrates such as Grizzly Bear (*Ursus arctos*) in the Lower 48 states (Rosen 2007), whereas in Canada designatable units have been also applied to vascular plants, lichens, mussels and insects.

The ESA has a long history of negotiating and implementing conservation on private lands (Davis et al. 2005), including many legal challenges (Plater 2004; Simberloff 1987). In 1982, the ESA was amended to introduce *Habitat Conservation Plans* to provide private landowners with long-term assurances about land use restrictions in exchange for conservation measures. While these agreements can result in loss of habitat for the endangered species, there is general consensus that endangered species benefit (Langpap & Kerkvliet 2012). In addition to supporting regulatory compliance, these agreements foster cooperation between governments, landowners, and interest groups. Despite a focus on federal regulation, the US has overcome many stewardship challenges and other issues related to endangered species conservation on private lands.

The ESA has prevented the extinction of roughly 291 species, and more than 99% of species under its protection remain extant (Greenwald et al. 2019). It has been particularly effective for marine mammals and turtles that were threatened with over-exploitation (Valdivia et al. 2019). There is also evidence that recovery plans and critical habitat are effective because they spark conservation action (Taylor et al. 2005). However, 52% of listed species are continuing to decline and few species are down-listed or delisted (Evans et al. 2016). Since being enacted, four species listed under ESA have become extinct and 22 are possibly extinct (Greenwald et al. 2019). As with Canada and Australia, there are many other

species that have not been listed by national endangered species legislation and have continued to decline.

Table 21: Summary of species diversity and endangered species legislation in Canada, Australia and the US

Attribute	Canada	Australia	United States
Number of Listed Species ¹	688	1,890	2,532
Number of Globally Imperiled Species ²	1,616	Undetermined	17,634
Percent of Listed Species that are Globally Imperiled ³	Approx. 10% (Raymond et al. 2018)	Estimated 80%	<99%
Number of Nationally Endemic Mammals and Birds ⁴	5	611 ⁵	180
Number of Extinctions ⁶	10	41 (territories not included)	285 (territories not included)
Legislation, Year	<i>Species at Risk Act (SARA)</i> , 2002	<i>Environmental Protection and Biodiversity Conservation Act (EPBC Act)</i> , 1999	<i>Endangered Species Act (ESA)</i> , 1973
Assessment Categories	Extinct, Extirpated, Endangered, Threatened, Special Concern, Not at Risk, Data Deficient, Non-active ⁷	Extinct, Extinct in the Wild, Critically Endangered, Vulnerable, Conservation Dependent	Extinct, Endangered, Threatened, Warranted but precluded, Endangered or Threatened due to similarity of appearance, Candidate ⁸
Taxonomical Units	Species, infraspecies, designatable units	Species, infraspecies + ecological communities and threatening processes	Species, infraspecies, distinct population segments
Assessment Criteria	Based on IUCN Red List	Based on IUCN Red List	ESA Assessment Criteria
Private/ Federal Land (%)	11%/41% (Neimanis 2013)	63%/<10% (Australian Bureau of Statistics 2020)	57%/28% (Hardy Vincent et al. 2017)
Annual Spending on Endangered Species (USD)	\$60M (Smart Prosperity Institute 2018)	\$92M (Wintle et al. 2019)	\$1.478B (USFWS, 2016a)

¹ Canada - Species at Risk Public Registry: Extirpated, Endangered, Threatened, Special Concern; US - Environmental Conservation Online System: Endangered, Threatened, Emergency Listing, Endangered, Emergency Listing, Threatened, Experimental Population, Essential, Experimental Population, Non-Essential, Similarity of Appearance (Endangered), Similarity of Appearance (Threatened); Australia - EPBC Act List of Threatened Fauna + Flora, includes Extinct species.

² Search of NatureServe: country + G1, G2, G3, GH, GX (Canada and US only). No sources found for Australia. Given the high number of endemic species, the number of species of global conservation concern is likely in the tens of thousands.

³ US number based on NatureServe Explorer search for ESA Endangered and Threatened species + global rank. Six species of 1,538 are globally secure (G4, T4). AUS number from Species Profile and Threats Database query. Based on listed species that have been assessed as threatened on the IUCN Red List (290/362).

⁴ Full species only. (IUCN 2019c)

⁵ Approximately 40% of Australian vertebrates and 84% of plants are endemic (Chapman, 2009).

⁶ IUCN Red List, 'Extinct' and 'Extinct in the Wild' categories. Over 50% of US extinctions are from Hawaii.

⁷ COSEWIC also maintains a candidate list of species for assessment.

⁸ Populations can also be designated as "experimental" or "non-essential". "Partial status" applied when status only applied to a portion of the species range.

4.2.4 THE SAME RESULTS

Between the three case study jurisdictions, there is over 85 years of experience in implementing contemporary national endangered species legislation. While there is evidence that endangered species listing and recovery have slowed species declines and there have been notable recoveries, the results have been the same: none of the approaches have been fully effective in preventing the decline and loss of endangered species. In the next section we explore some of the barriers that are preventing more effective recovery.

4.3 A REVIEW OF BARRIERS TO ENDANGERED SPECIES RECOVERY

Several recent studies have examined the effectiveness of the IUCN Red List (Betts et al. 2020), ESA (Evans et al. 2016) and EPBC (Scheele et al. 2018) (**Table 22**). In addition to reviewing these benchmark studies, we conducted a literature search in the Web of Science on national endangered species legislation from the three case study countries. We searched by country/ national legislation name, and by the name of the country and the nomenclature commonly used to describe threatened species (e.g. “Canada” + “Species at Risk Act”; “Canada” + “species at risk”; “United States” + “Endangered Species Act”; “United States” + “endangered species”; “Australia” + “Environment Protection and Biodiversity Conservation Act”; “Australia” + “threatened species”). We screened our results to focus on papers from the last decade that identified issues with current approaches and proposed opportunities to overcome these issues. We also searched Google News for these terms to identify current events related to changes in endangered species legislation.

We reviewed these papers through a Canadian lens and organized the barriers they identified based on the components of Canada’s *Species at Risk Conservation Cycle*: assessment, protection, recovery planning, implementation, and monitoring and evaluation (ECCC 2018a) (**Table 23**). The results of our review are not intended to catalogue criticisms of current approaches, but to identify key issues that may limit our current response to wildlife decline.

The barriers we identified are diverse but also interrelated. They include the economic barriers of perverse incentives (Langpap & Wu 2017), political barriers such as delays in government listing (Ferreira et al. 2019), structural barriers that discourage qualitative measures (Doak et al. 2015) and reporting (Bottrill et al. 2011), and social barriers that range from our bias towards certain species (Bellon 2019) to the traditional paucity of social sciences in conservation (Bennett, Roth, Klain, Chan, Christie, et al. 2017). Some of the barriers are deeply rooted in constitutional frameworks and the division of powers including Indigenous rights, treaties, and land claims.

Funding is certainly a key issue for species recovery (Gerber 2016; Luther et al. 2016; Wintle et al. 2019), and will be important to help overcome some of these barriers (Langpap et al. 2018). Change in political leadership has also been shown to influence endangered species policy and implementation (Bergman et al. 2020; Lambert 2019). However, we have chosen to focus on new approaches and not directly include funding or political change in the bridges we identified to overcome these barriers.

Table 22: Summary of Recommendations by Recent Reviews of IUCN Red List, ESA & EPBC

IUCN Red List	United States	Australia
(Betts et al. 2020)	(Evans et al. 2016)	(Scheele et al. 2018)
1. Improve scientific knowledge. 2. Raise awareness of conservation issues. 3. Better understand conservation priorities and planning. 4. More or better targeted funding and resource allocation. 5. Legal and policy development or change. 6. More or better targeted conservation action.	1. Establish and consistently apply a system for prioritizing recovery funding. 2. Strengthen partnerships for species recovery by expanding collaboration and by developing incentives for private landowners. 3. Promote more monitoring and adaptive management for species recovery. 4. Refine methods to develop more objective, measurable recovery criteria. 5. Use well-established climate-smart conservation strategies. 6. Evaluate ecosystem-based approaches such as surrogate species and coarse ecological filters to develop methods that increase the efficiency of managing for recovery.	1. Stakeholder engagement and communication. 2. Foster strong leadership and the development of achievable long-term goals. 3. Knowledge of target species' biology and threats, particularly focusing on filling knowledge gaps that impede management, while noting that in many cases there will be a need for conservation management to proceed initially despite knowledge gaps. 4. Setting objectives with measurable outcomes. 5. Strategic monitoring to evaluate management effectiveness. 6. Greater accountability for species declines and failure to recover species to ensure timely action and guard against complacency.

Table 23: Barriers and opportunities for endangered species recovery

Barriers	Description of Barrier	Proposed Opportunities
ASSESSMENT The missed opportunity of prelisting conservation	Few programs support conservation of species before they are listed. Canada's Habitat Stewardship Program (HSP) only funds recovery actions for listed species. HSP did incorporate a "prevention stream" funding program starting in 2014-15, but it has been discontinued and is not included in the new Pan-Canadian Approach. Wildlife recovery can be less expensive and more effective when deployed before species populations reach crisis levels (Li & Male 2015).	There are hundreds of species that could be eligible for SARA listing. Canada's Habitat Stewardship Prevention Stream could be reintroduced, or a COSEWIC candidate species incorporated into assessments and recovery strategies. Prelisting conservation of candidate species has successfully prevented candidate species from being listed in the US (Donlan 2015). Tools ranging from RAMAS software to machine-learning (Pelletier et al. 2018) can rapidly assess species that are likely to be assessed as at risk so that early conservation interventions can be supported.
ASSESSMENT/ PROTECTION Unmanageable backlog of species to assess and list	Many threatened species are not listed. For example of 22 species of fishes identified as highly threatened by experts in Australia, 19 are unlisted (Lintermans et al. 2020). COSEWIC has a backlog of species that may warrant listing. There are currently over 500 vascular plants on the COSEWIC candidate list. While the full costs for SARA listing have not been determined, in 2021 the average contract value to prepare a new assessment for vascular plants was \$11,200. Many species that are critically imperiled in Canada, such as Cleland's Evening-primrose (<i>Oenothera clelandii</i>) have been on the COSEWIC candidate list for years while their status has likely deteriorated.	Many species that are assessed and listed could serve as umbrella species (Simberloff 1998) for candidate species. Assessment and recovery planning can also be done for higher taxonomic groups (e.g. dragonflies) or indicator species (Braby 2018). While Australia lists threatened ecological communities, this could be complimented by identifying and listing faunal communities (Fraser et al. 2019). Canadian examples of faunal communities would include grassland birds or Great Lakes coast wetland fishes. This could be a gateway to ecosystem approaches to listing and recovery or bundling species assessments. Species that are assessed as at risk, and then down-listed based on non-genuine status changes, such as the discovery of additional populations (IUCN 2020) also add to the backlog (e.g. Pygmy Pocket Moss [<i>Fissidens exilis</i>]). More surveys before listing and the use of species distribution models are needed (McCune 2019).
ASSESSMENT/ PROTECTION Too much focus on range edge species	Many species at risk in Canada reach their northern range limit in southern Canada (Glass et al. 2017). A study on vascular plants found that almost 80% of listed species at "edge" species (Klemet-N'Guessan et al. 2019). While nationally imperiled, they are often globally common. Canada's conservation of these species does not support global conservation efforts. Edge of range species are prioritized over global status (Raymond et al. 2018).	The purpose of SARA protected all wild species. While some edge of range species that are globally secure may be a lower priority for conservation in Canada, species redistribution science (Bonebrake et al. 2018) is providing new approaches to assess which edge of range species may be critical to support climate change driven range shifts, and that 'leading edges' should be targeted for conservation (Gilbert et al. 2019). For example the range of American Chestnut (<i>Castanea dentata</i>) is projected to shift northward (Barnes & Delborne 2019) and the Canadian 'edge' could play an important role in its conservation. The significance of Canadian edge populations in global conservation could be used to prioritize edge species.

Barriers	Description of Barrier	Proposed Opportunities
ASSESSMENT/ PROTECTION Biases of charismatic species	Charismatic species are more likely to be listed as threatened and receive funding for conservation actions leading to the neglect of other taxonomic groups (Bellon 2019; Creighton & Bennett 2019; Mammides 2019; Mooers et al. 2007; Walsh et al. 2013). Charismatic species are also more likely to have specific recovery strategy targets (Théberge & Nocera 2014). Birds and mammals generally require more resources to recover resulting in unequal resource allocation among taxonomic groups (Gordon et al. 2019).	The public is attracted to charismatic species, and these can be used as flagships to leverage conservation (McGowan et al. 2020; Thompson & Rog 2019). Scientists that prioritize species and prepare assessments and recovery plans can unconsciously commit “stealth policy advocacy” (Wilhere 2017). This can be reduced by training and awareness of motivational and other sources of bias (Burgman 2004). Priority lists should be prepared that are focused on extinction risk. In Canada vertebrate experts may now become focused on reassessments rather than new assessments since there has been a bias on assessing these taxa.
PROTECTION Delayed listing	Delays in listing species after they are assessed has been identified as a key issue in Canada (Ferreira et al. 2019) and the US (Malcom & Li 2018; Puckett et al. 2016; Walls et al. 2017).	Listing delays in Canada tend to be for widespread but declining species that intersect with major land uses. For these species, an initial listing could be limited to Special Concern which will not trigger critical habitat designations. This would allow government and user groups to develop and implement conservation strategies to prevent future listing as Threatened or Endangered.
RECOVERY PLANNING Delayed recovery plans	Delays in developing recovery plans are a significant barrier in endangered species conservation (Mooers et al. 2007; Mooers et al. 2010). In the US, one-fourth of listed species lack final recovery plans and half of recovery plans are more than 20 years old. There is also significant variation in planning between agencies, and among regions and taxonomic groups (Malcom & Li 2018).	Recovery plans may not actually impact the status of species (Bottrill et al. 2011), and just assessment should trigger conservation actions. Recovery planning could also be streamlined in Canada by not repeating detailed information that is previously covered in assessments including biology of the species and threats. Involving COSEWIC in recovery planning or at least setting thresholds for recovery during species assessments would be consistent with approaches in Australia and the US and could help improve and streamline the process.
RECOVERY PLANNING Delayed identification of critical habitat	The protection of critical habitat is one of the most contentious decisions of environmental agencies (Martin et al. 2017). In Canada 62.9% of listed species lack critical habitat designation (Bird & Hodges 2017). The US Fish and Wildlife Service often has not designated critical habitat, based on the legal exceptions in the ESA of “not prudent” or “not determinable” (Hagen & Hodges 2006).	Critical habitat may not actually be effective for species conservation. In the US critical habitat designation did not have a significant impact on land use change, especially when compared to other factors such as land prices (Nelson et al. 2017). However, in Australia species with critical habitat were more likely to be improving (Taylor et al. 2005). In Canada, most critical habitat is primarily designated on federal lands that are already protected. Fear of lawsuits and backlash makes governments hesitant to introduce critical habitat. Critical habitat is probably not the best term to market conservation to private landowners. Introduction of Habitat Conservation Plans (used in the US), greater public awareness and locally led implementation (Jones et al. 2019) could reduce the opposition.

Barriers	Description of Barrier	Proposed Opportunities
RECOVERY PLANNING Climate change not considered in recovery	An estimated that 15–37% of species may be ‘committed to extinction’ as a result of climate change (Thomas et al. 2004), although there are knowledge gaps regarding adaptation, microhabitat buffering, accuracy of models and tipping points (Moritz & Agudo 2013). Threatened and endangered species are likely to be disproportionately affected by climate change because they are often habitat specialists and rare. In the US agencies consider climate change as a threat to 64% of species but plan management actions for only 18% (Delach et al. 2019). In Australia, just under 60% of the sampled recovery plans listed climate change as threat and only 22%, identified specific actions (Hoepfner & Hughes 2019).	There are tools that can model future habitat (e.g. Maxent and bioclimatic modeling) and this information can be incorporated into recovery actions, refine climate change threat and prioritize species (Stewart et al. 2018; Wilkening et al. 2019). Practitioners may need to re-consider the concept of native range (Pereyra 2020) and be prepared for assisted migration. Conservation banking or other offsets could be targeted at areas where species are likely to occur in the future (i.e. climate banking) (Whipps 2015). Approaches to climate banking include future habitats, ark easements and stepping stones (Kimbrell 2010).
RECOVERY PLANNING Inconsistent or ineffective threat assessment and recovery criteria	Recovery plans have diverse authors and approaches can be inconsistent, particularly in how threats are assessed and recovery criteria developed (Brigham et al. 2002; Ortega-Argueta et al. 2017; Scheele et al. 2018). Recovery objectives often lack qualitative measures to assesses recovery progress (Doak et al. 2015) or don’t incorporate the full suite of criteria needed to assess success (Wolf et al. 2015).	Expert judgements in assessing status and threats are subject to heuristics that can bias judgements (Heeren et al. 2017). Providing tools to avoid these will improve consistency. In Canada, the adoption of the IUCN threats calculator has improved consistency in threats assessment, although there is no requirement to justify decisions with data. Using climate vulnerability assessment tools would improve predictions for the threat of climate change (Young et al. 2010). Authors need guidance on developing recovery criteria and thresholds (Che-Castaldo & Neel 2016; Ortega-Argueta & Contreras-Hernández 2013). An analysis of past recoveries and a database on recovery objectives, thresholds and actions would support greater consistency. Metrics of threats progress would also support comparisons (Garnett et al. 2019)
IMPLEMENTATION Lack of engagement & use of social sciences	While conservation may be about the state of biodiversity, implementation requires changes in social systems including values, beliefs and norms. Although there is an on-going shift in conservation towards social and political factors (Hintzen et al. 2020), traditionally conservation has not fully incorporated social sciences due to ideological, institutional, knowledge, and capacity barriers (Bennett, Roth, Klain, Chan, Clark, et al. 2017).	Broader engagement informs management and outreach decisions and enhances collaborative decision-making, which results in improved conservation outcomes (Rodgers et al. 2017; Sawchuk et al. 2015). While species assessments are beginning to incorporate Indigenous traditional knowledge (Hill et al. 2019), they do not address the social landscapes where species live (other than threats). Adding community knowledge and values to assessments, engaging social scientists in recovery actions and including communications and marketing plans in recovery strategies could improve their effectiveness.
IMPLEMENTATION Failure to protect critical habitat	Often critical habitat protection is not enforced. In Australia over 7.7 million ha of potential threatened species habitat and threatened communities were cleared in the period 2000–2017 (Ward et al. 2019). In Canada, critical habitat is lost through exemptions to user groups including agriculture and forestry.	Offsetting and habitat banks based on the principle of ‘net positive gain’ (Bull et al. 2019) could support a more flexible approach to critical habitat protection. Flexible market-based approaches to implementing SARA would increase support, reduce conflicts and, if properly implemented, lead to better conservation outcomes (Smart Prosperity Institute 2018).

Barriers	Description of Barrier	Proposed Opportunities
IMPLEMENTATION Insufficient critical habitat	Critical habitat is often not based on the needs of the species to persist because of data limitations or a desire to limit conflicts with resource users and potential legal challenges (Camaclang et al. 2015).	Evidence on the effectiveness of critical habitat in supporting species recovery is mixed, but it appears to be less important than a recovery plan (Langpap et al. 2018). For some species, critical habitat designation should be more flexible, including non-regulatory designations.
IMPLEMENTATION Perverse incentives	Regulations and habitat designations, both enacted and pending, can create an incentive for landowners to remove habitat to avoid regulation (Langpap & Wu 2017; Ward et al. 2019).	Enhance initiatives on private land by making government-funded stewardship programs more directed, flexible, and incentive-based (Smart Prosperity Institute 2018) Local implementation can reduce perceived threats of regulation (Jones et al. 2019). Incentive programs such as cost sharing and compensation can increase adoption of species stewardship activities (Pittman 2019) and help overcome perverse incentives created by regulation (Langpap et al. 2018).
IMPLEMENTATION Key and cumulative threats not effectively managed	Recovery strategies may not address key threats. Prioritizing strategies based on the prevalence of threats may have a low probability of success and not be cost-effective (Butt et al. 2020).	In addition to IUCN threats categorization and calculation and prioritizing threats based on impact, threats need to be prioritized by management effectiveness (Carwardine et al. 2019) and probability of success (Prugh et al. 2010). Place-based approaches in endangered species hot-spots may be better positioned to understand and mitigate cumulative threats than actions based on individual species.
IMPLEMENTATION Protected areas not effectively identified, created or managed	There is often a mismatch between protected areas and key areas for endangered species (Rodrigues et al. 2004). This pattern is well known from Canada (Deguise & Kerr 2006) where the Mixedwood Plains Ecozone has one of the country's highest numbers of endangered species and only 1.9% is protected (ECCC 2021a). Protected areas can give a false sense of conservation if they are unable to manage continued threats (Kearney et al. 2020). In Canada the primary threat to species with recovery plans was recreation, primarily within protected areas (McCune et al. 2013).	Protected areas can be very effective. Endangered species with most of their range in protected areas are more likely to have stable or increasing populations (Taylor et al. 2011). Biodiversity is higher in protected areas than the surrounding landscape (Gray et al. 2016). Protected areas may also provide important climate change buffers where species can persist as broader landscape strategies are developed (Lehikoinen et al. 2019). Systematic conservation planning (Margules & Pressey 2000) has been effective in Australia to align new protected areas with key areas for threatened species (Barr et al. 2016). Conservation planning tools can also incorporate costs in setting spatial priorities (Carwardine et al. 2008). The Key Biodiversity Area initiative will support the identification of critical areas (IUCN 2016).
MONITORING & EVALUATION Lack of accounting and reporting	The lack of basic accounting in recovery strategies makes it difficult to assess their effectiveness (Bottrill et al. 2011). In Canada species recovery is most often reported as case studies and examples rather than a systematic account and analysis of results and factors of success.	Better accounting of recovery plans promotes transparency, improves future actions and investments (Bottrill et al. 2011) and can be enhanced by regular monitoring and reporting (Ortega-Argueta 2019). Canada's reporting once done by the Recovery of Nationally Endangered Wildlife program should be reinvigorated to consolidate and share lessons of recovery.

4.4 TEN BRIDGES ON THE ROAD TO RECOVERY

We developed our ten bridges to help span the gap from our current state of wildlife loss to a future state of recovery. We recognize that building and crossing many of these bridges will require transformative change. Fortunately, calls for transformation in the conservation of wild species are being made. For example, the recent global assessment by the *Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services* has called for ‘transformative changes’ across social, political and technological dimensions of society (Bridgewater et al. 2019; Díaz et al. 2019). The new *Pan-Canadian Approach to Species at Risk Conservation* calls for a “transformative approach to operationalizing species at risk conservation” (ECCC 2018b). As part of this transformation the pan-Canadian approach has also identified priority places, priority species and priority threats and sectors, and the goals include better outcomes for species at risk and increased co-benefits for biodiversity and ecosystems.

Our definition of this transformation is a change in the trajectory of widespread biodiversity loss to that of recovery and, ultimately, zero extinction. A global vision of this transformation has recently been expressed in the *Abu Dhabi Call for Global Species Conservation Action* to prevent human-driven extinctions by 2030 (IUCN 2019a). Achieving this vision will require a rethink of our current conservation practices, and, ultimately, our relationship with nature.

Based on the barriers we summarized in our synthesis of the literature (**Table 23**) we identified ten bridges that could provide solutions (**Table 24**) (Gunderson et al. 1995). These ten bridges (**Box 4.1**) are intended to support the direction of the *Pan-Canadian Approach* and the transformation of endangered species recovery, with a goal of halting extinctions and extirpations from Canada.

Box 4.1: Ten Bridges to Support Transformation of Endangered Species Recovery in Canada

1. *National action for global priorities*
2. *Place-based and threat-based recovery*
3. *Clearer recovery targets*
4. *Species recovery through ecosystems approaches*
5. *Building capacity for community co-governance*
6. *Significant net gain*
7. *Document the full benefits of recovery*
8. *Ambitious and future-forward translocations*
9. *Species need stories*
10. *Share success (and failure)*

Table 24: Summary of barriers and bridges for endangered species recovery

Barriers	Key Bridges
ASSESSMENT The missed opportunity of prelisting conservation	<i>Place-based and threat-based recovery</i> <i>Species recovery through ecosystems approaches</i> <i>Building capacity for community co-governance</i>
ASSESSMENT/ PROTECTION Unmanageable backlog of species to assess and list	<i>Place-based and threat-based recovery</i> <i>Species recovery through ecosystems approaches</i>
ASSESSMENT/ PROTECTION Too much focus on range edge species	<i>National action for global priorities</i> <i>Species recovery through ecosystems approaches</i>
ASSESSMENT/ PROTECTION Biases of charismatic species	<i>National action for global priorities</i> <i>Species recovery through ecosystems approaches</i>
PROTECTION Delayed listing	<i>Place-based and threat-based recovery</i> <i>Species recovery through ecosystems approaches</i>
RECOVERY PLANNING Delayed recovery plans	<i>Species recovery through ecosystems approaches</i> <i>Building capacity for community co-governance</i>
RECOVERY PLANNING Delayed identification of critical habitat	<i>Species recovery through ecosystems approaches</i>
RECOVERY PLANNING Climate change not considered in recovery	<i>Place-based and threat-based recovery</i> <i>Ambitious and future-forward translocations</i>
RECOVERY PLANNING Inconsistent or ineffective threat assessment and recovery criteria	<i>Clearer recovery targets</i> <i>Ambitious and future-forward translocations</i>
IMPLEMENTATION Lack of engagement & use of social sciences	<i>Building capacity for community co-governance</i> <i>Significant net gain</i> <i>Document the full benefits of recovery</i> <i>Species need stories</i>
IMPLEMENTATION Failure to protect critical habitat	<i>Significant net gain</i> <i>Document the full benefits of recovery</i>
IMPLEMENTATION Insufficient critical habitat	<i>Significant net gain</i>
IMPLEMENTATION Perverse incentives	<i>Significant net gain</i> <i>Document the full benefits of recovery</i> <i>Building capacity for community co-governance</i>
IMPLEMENTATION Key and cumulative threats not effectively managed	<i>Place-based and threat-based recovery</i> <i>Significant net gain</i>
IMPLEMENTATION Protected areas not effectively identified, created or managed	<i>Place-based and threat-based recovery</i> <i>Species recovery through ecosystems approaches</i> <i>Building capacity for community co-governance</i>
MONITORING & EVALUATION Lack of accounting and reporting	<i>Clearer recovery targets</i> <i>Species need stories</i> <i>Share success (and failure)</i>

4.4.1 NATIONAL ACTION FOR GLOBAL PRIORITIES

More focus on globally imperiled and endemic species will support endangered species conservation in Canada and is our most important contribution to stopping extinction.

Canada has not prioritized globally at risk and nationally endemic species for conservation (Raymond et al. 2018). Of the 381 species and 188 infraspecies that are globally imperiled based on NatureServe conservation status ranks (Rainer et al. 2017, Appendix B) only 34% have been assessed by COSEWIC, and COSEWIC has assessed less than 20% of Canada's 308 nationally endemic species and infraspecies (Enns et al. 2020). This is in sharp contrast to Australia and the US where most nationally listed species are also globally imperiled (**Table 20**). SARA does not prioritize, but COSEWIC has latitude to refocus on species of global conservation concern. Prioritization of candidate species already includes global status and Canadian responsibility, including endemism (COSEWIC 2022). COSEWIC could expand on existing taxon-based candidate lists to create a master list of Canadian species of global conservation concern based on NatureServe conservation status ranks and the IUCN Red List of Threatened Species to prioritize future assessments that are based on endemism and global rank. Ensuring that all species of global conservation concern are priority candidates for assessment and subjected to the prioritization exercise will support both the purpose of SARA and Canada's commitments to protect global biodiversity under the CBD.

Unless additional resources are provided to COSEWIC, expanded global prioritization may result in a conservation trade-off between assessing globally imperiled species and species at the northern edge of their range or designatable units. The reassessment of globally secure species that are listed under SARA could be deferred unless there is a high probability of a status change to create additional capacity to assess globally imperiled and endemic species. These trade-offs are not ideal. The purpose of SARA is to provide for the recovery of all wildlife that is at risk, and designatable units and species at the northern edge of their range can have important evolutionary significance (Glass et al. 2017). But trade-offs are already being made in current approaches in deciding which species to assess. Our future conservation prioritization should be deliberate and deliberated in consideration of global status, genetic distinctiveness, significance as leading-edge populations (Carvalho et al. 2019) and potential for future reintroduction.

4.4.2 PLACE-BASED AND THREAT-BASED RECOVERY

Clearly grouping species that can best be protected through place-based actions and species that need threat mitigation would support and accelerate conservation efforts.

How species are protected should depend on intrinsic extinction risks and threats. Very different approaches are needed to conserve 'declining populations', 'small populations' (Caughley 1994), and 'recovering populations' (Hutchings 2015). Species that have small ranges, low numbers and narrow habitat specificity are the most vulnerable to changes in land use (Sykes et al. 2020), stochastic events (Smith & Almeida 2019) and ultimately to extinction (Staudé et al. 2020). These species should be the focus of the most urgent conservation actions including habitat protection and translocations, particularly when they are endemic or of global conservation concern.

Many 'small population' species can be directly conserved through place-based actions. A comprehensive national strategy to include these in Canada's new protected areas would support their conservation. Over 60% of Canada's species at risk occur in nine "crisis ecoregions" that cover just 5% of Canada's lands and inland waters (Kraus & Hebb 2020) and many, 'small population' endangered species co-occur in remnant habitats. New protected areas and habitat restoration in these areas can

support the conservation of small population endangered species. The spatial extent of these areas need to be clearly identified and prioritized beyond the current number and spatial scale of ‘Priority Places’ (ECCC 2018b). Many of the areas that support a high richness of species at risk are known and could be refined by combining existing data sets and through species distribution models (Rosner-Katz et al. 2020). Multiple species that are spatially restricted can often be effectively conserved through ecosystem approaches (see Bridge 4).

Although wildlife recovery in Canada was founded on the protection of common species that had become scarce (e.g. Plains Bison [*Bison bison bison*], Pronghorn [*Antilocapra americana*]), proactive protection of common but declining species to prevent future endangerment is relatively new to conservation. For the first 21 years of COSEWIC qualitative criteria that focused on species with small ranges and populations were applied to assess risk (Shank 1999). Adoption of the IUCN criteria (IUCN Standards and Petitions Subcommittee 2019), and in particular criterion A (declining populations) has resulted in the listing of species that are still common and widespread but rapidly declining such as Barn Swallow (*Hirundo rustica*) and Snapping Turtle (*Chelydra serpentina*). These species often occur in regions dominated by farms, cities and forestry and have been the source of much of the conflict and criticism around SARA (e.g. Boan et al. 2018).

Conservation of these species will often require changes in socio-economic systems. Depending on the rate of decline there may be more time to formulate and implement recovery strategies for this group than for species with small populations or ranges. In the case of common but declining species, delayed listing could be beneficial if that time is used to constructively build alliances and support for recovery. Preemptive and cooperative conservation actions that could reduce future regulation can be used as an incentive to spark and implement threat mitigation strategies. Current initiatives of the federal government to engage priority sectors (forestry, agriculture, urban) in species at risk recovery and priority threat management approaches (Carwardine et al. 2018) may lead to new models of co-governance (see Bridge 5).

Categorizing species during the assessment process into clear “risk/recovery groups” based on their needs for place-based or threat-based recovery could help to accelerate and coordinate conservation actions by grouping species that can be conserved at common locations or by managing common threats. These categories could be based on existing assessment criteria (e.g. declining or small population) and other factors such as habitat, highest threats and location). This approach would provide direction to recovery strategy authors, highlight existing species in the same risk/recovery group so that current actions can be incorporated into new recovery plans, facilitate the coordination of actions, and encourage actions prior to a final recovery strategy. A simple one-page addendum to existing COSEWIC assessments that provides the committee’s perspectives on general recovery needs would help to jump-start both recovery planning and actions.

4.4.3 CLEARER RECOVERY TARGETS

Recovery goals with clear benchmarks makes it easier to measure progress and are more likely to be achieved.

Canadian recovery strategies lack consistency in applying measurable and timebound objectives and thresholds. These are precisely the types of conservation targets that are more likely to be achieved (Green et al. 2019). Quantitative metrics allow practitioners to focus on goals and report on the recovery of endangered species (Gerber & Hatch 2002). Quantifiable and ambitious goals are more prevalent under the ESA than SARA (Pawluk et al. 2019). Clearer recovery targets would also allow progress across

taxa and jurisdictions to be better tracked, support the identification of best practices, and help practitioners focus on actions that have the highest probability of moving a species towards a defined threshold.

SARA requires the development of one or more action plans based on the recovery strategy for species listed as extirpated, endangered or threatened. These action plans often contain more detail on timelines and quantifiable measures. There may be both planning efficiencies and opportunities to improve recovery effectiveness if the quantitative information in actions plans was not delayed and completed during the recovery planning process.

Clear recovery goals are not consistently defined. Charismatic species have more specific recovery goals (Théberge & Nocera 2014) and fishes have a higher proportion of quantitative and ambitious goals compared to other taxa (Pawluk et al. 2019). For fishes, this may be the result of *Recovery Potential Assessments* (RPA) (DFO, 2007) that are often prepared by Department of Fisheries and Oceans scientists following the COSEWIC assessment.

Many recovery strategies in Canada are also not ambitious. They not only lack clear targets, but they do not aim to change species status. For example, Drooping Trillium (*Trillium flexipes*) could potentially be reassessed from Endangered to Threatened if the number of locations was increased from two (the current number) to greater than five (the threshold for Endangered under assessment criteria B). This threshold to nudge the species to a lower status category and associated actions are not included in its recovery strategy (Environment Canada 2016). However, some recent recovery strategies, such as Sharp-tailed Snake (*Contia tenuis*) (ECCC 2020b), very clearly discuss the links between assessment categories and criteria to recovery potential and could serve as a model.

While change in status is not necessarily the same as full recovery (Akçakaya et al. 2018), clearer recovery targets that strive for status improvements would encourage actions that reduce extinction risk. A guide to identifying targets and thresholds would support recovery efforts and could be modeled on the primer to evaluate restoration success (Prach et al. 2019). Recovery strategies could incorporate long and short term objectives with indicators of success that are leading (inform preventative actions), coincident (measure current state) and lagging (change as a result of actions) (Stevenson et al. 2020). The current approaches used in RPAs for aquatic species (DFO, 2007) could also be incorporated into recovery strategies for all taxa. The new global standard on the Green List of Species may also provide a tool for recovery strategy authors to identify strategies to both reduce extinction risk (i.e. change assessment category) but also to quantify species recovery and measure progress (Grace 2020, submitted)

4.4.4 SPECIES RECOVERY THROUGH ECOSYSTEM APPROACHES

Managing multiple species through ecosystem approaches improves efficiency and can help conserve other species of conservation concern before they are listed.

Traditional single species approaches to recovery have been very successful for some wildlife, but as the list of species at risk grows many endangered species can no longer be effectively managed individually. Although multi-species recovery plans may be less effective for individual species (Greenwald et al. 2019), ecosystem-based approaches increase efficiency and provide protection to other species of conservation concern. These approaches can also reduce potential management conflicts. For example, on Pelee Island in Lake Erie prescribed fires maintain habitat for the Endangered Blue Racer (*Coluber constrictor foxii*), but can also eliminate habitat for the Endangered Yellow-breasted Chat virens

subspecies (*Icteria virens virens*) (ECCC 2019c). Ecosystem approaches can help managers identify these species interactions and conflicts and develop actions that coordinate and maximize conservation outcomes.

Multi-species and ecosystem-based planning in species-rich focal areas would have similarities to the Australian approach of listing threatened ecological communities and could prioritize actions to reduce threats in that specific area. Developing, implementing and reporting on ecosystem-based plans, that integrate terrestrial and aquatic species (which would require cooperative planning and recovery between ECCC and DFO), and include candidate and other species of conservation concern would support multi-species ecosystem planning and recovery.

Multi-species or ecosystem approaches are permissible under SARA (section 41 (3)) but have not yet widely been implemented as policy. With only a few exceptions, COSEWIC assessments and recovery strategies and management plans are based on single-species approaches. Multi-species and ecosystem-based approaches are more prevalent in action plans, with 67 final action plans that address more than one species at risk. However, almost two-thirds of these are for aquatic species and multi-species plans for species at risk found in national parks.

Ecosystem approaches will require flexibility, and even experimentation on how SARA is implemented. Although the diversity of provincial and territorial approaches to implementing the federal *Species at Risk Act* may seem like a policy patchwork, the science of endangered species protection and recovery is still emerging. Organization and innovation at sub-national levels may be necessary to drive change, and to provide sustainability experimentation (Leach et al. 2012) that is needed to find practical solutions at larger scales. However, this must be supported by rigorous monitoring and sharing of innovation and best practices (see Bridge 10).

4.4.5 BUILDING CAPACITY FOR COMMUNITY CO-GOVERNANCE

Engaging local communities and stakeholders in decision-making and implementation can be complex, but it will improve wildlife recovery outcomes.

Building on the theory and experience of ecosystem-based management that calls for participatory, consultative approaches (Slocombe 1993), co-management or co-governance approaches are showing promise for wildlife conservation since they encourage learning among practitioners and adaptive decision making (Decker et al. 2016). The recent *Edinburgh Declaration on post-2020 global biodiversity framework* also calls for the increase participation of local government and groups in implementation of the Aichi targets.

There have been some promising recent trends towards co-governance models for the management of endangered species in Canada. The *Species at Risk Partnerships on Agricultural Lands* program in western Canada is implemented by Rancher's Stewardship Alliance and incorporates ranchers' contributions into stewardship (Pittman 2019). One of the challenges of these incentive-based programs is that landowners that have previously adopted practices to protect wildlife habitat may not be rewarded. However, they have been shown to build trust and increase cooperation (Jones et al. 2019). These programs can also provide a buffer to changing government priorities if local groups that are implementing recovery action have access to multiple streams of funding.

Incorporating social and behavioral sciences into conservation results in better conservation outcomes (Cinner 2018). However, recovery strategies do not always identify objectives and actions that integrate

participation by communities, community-based organizations or local authorities. Building social-science capacity within governmental organizations that are responsible for wildlife recovery, providing policy-based training to recovery strategy authors on approaches that engage communities, and systematically sharing successful examples that link co-governance with improved species outcomes would support their integration. The template for recovery strategies could also be updated to include sections on community participation, such as the core principles of community-centered conservation governance that involves building multi-level collaborative networks, empowering local institutions and responding meaningfully to emerging political, economic and justice claims (e.g., from Indigenous Peoples) that result from historical or future land enclosures in the name of conservation or wildlife management (Armitage et al. 2020). In particular Indigenous Peoples have rights over many areas that are critical for wildlife (Schuster et al. 2019) and need to be more fully engaged in endangered species recovery (Hill et al. 2019).

4.4.6 SIGNIFICANT NET GAIN

If done properly, development can be used to leverage improvements in species status and turn traditional adversaries into future allies.

Species conservation is a complex social-ecological issue that will require many solutions. If done correctly, identifying, regulating and protecting critical habitat can be complemented by biodiversity offsets and habitat banking (Dupont 2019). These must be supported by rigorous guidelines that follow the mitigation hierarchy and include avoidance (e.g. critical habitat) and limits to offsets (i.e. not all species or subpopulations can be offset) (BBOP 2012; Arlidge, 2018).

Past biodiversity offset approaches of “no net loss” have generally resulted in habitat loss (Quigley & Harper 2006; Turner et al. 2001). Going forward offsets must use targets that unequivocally result in a significant net gain for impacted endangered species with the state and trajectory of the population clearly improved (Bull et al. 2019). In some cases, offsetting the loss of lower quality habitat for endangered species can be used to support recovery efforts. In Ontario, overall benefit permits issued under the provincial *Endangered Species Act* for construction of the Herb Gray Parkway in the City of Windsor significantly increased the habitat and numbers of the Endangered Colicroot (*Aletris farinosa*) (COSEWIC 2015a). Offsets and habitat banking may require managers of endangered species to develop population and habitat targets that go beyond existing sites, but these can incorporate the thresholds that are needed to improve conservation status. Offsetting also provides an opportunity to implement climate change adaptation strategies through restoration and translocation in future habitat areas (see Bridge 8) and can generate funding for research. It can also create new relationships as diverse stakeholders cooperatively engage to find solutions.

4.4.7 DOCUMENT THE FULL BENEFITS OF RECOVERY

Documenting the important benefits that habitat conservation and restoration provides to people can increase support and funding for wildlife recovery.

Wildlife recovery provides benefits beyond biodiversity. The current biodiversity crisis is interrelated and mutually enforcing of other crises including climate change (Gardner et al. 2020), the loss of ecosystem services (Díaz et al. 2019) and our current global pandemic (Kavousi et al. 2020). Evidence is mounting that human interaction with nature supports health and well-being (Maller et al. 2005) and provides critical benefits to our cultures and societies (Díaz et al. 2018) .

The interest, urgency and potential funding associated with maintaining and restoring ecological services (Cohen-Shacham et al. 2019; Seddon et al. 2020) is an opportunity to link wildlife recovery with the benefits that nature provides to people. Habitats that support ecological services and endangered species often overlap. The analysis of green infrastructure and biodiversity benefits from urban areas (Filazzola et al. 2019) could be applied to endangered species habitats allowing practitioners to target areas for ecological restoration that will also deliver a suite of wider social, and economic benefits (Gilby et al. 2020). Ecosystems services and their valuation have been applied to protected areas in Canada, such as Rouge Urban National Park (Wilson 2012), but not to habitat protection and restoration for species at risk.

Recovery strategies could project the value of the ecological services that species protection and restoration could provide. In particular linkages between habitat conservation and ‘nature-based solutions’ for climate change (Griscom et al. 2017) may broaden new partners and funding (Echols et al. 2019). For example, the restoration of riparian habitat is a recovery objective for the Endangered Lake Chubsucker (*Erimyzon sucetta*) (Staton 2010). Riparian habitats and forested headwaters provide habitat for the Lake Chubsucker but these same habitats also provide other important benefits such as water quality improvement and carbon sequestration (Hanna et al. 2019). The value of the services provided by forests in regions where the Lake Chubsucker lives in southern Ontario are over \$19,000/year/ha (TD Bank Group & Nature Conservancy of Canada 2017). Protecting and restoring this habitat would also create jobs and support Canada’s transition to a “restoration economy” (BenDor et al. 2017) and a post-COVID “green recovery” (Mansuy 2020). Describing and quantifying the potential ecological services and annual economic benefits of restoring riparian habitats and forested headwaters in the critical habitat of Lake Chubsucker would support the case for implementation that complements the needs of the species and links recovery to broader societal values.

This information could be incorporated into the existing section in COSEWIC assessments on “Special Significance of the Species” so it can be considered in the socioeconomic analysis of the listing process. Greater detail on the social and economic benefits could then be detailed in recovery strategies. This may require training for assessment and recovery strategy authors, or the engagement of other experts in developing this information.

By incorporating the ecological services that are associated with endangered species conservation, the economic and social values of conservation can be communicated with a message that may resonate with a broader suite of actors (see Bridge 9). The integration of social and ecological targets make the interdependences between biodiversity and ecological services more explicit (Reyers & Selig 2020). The need to use socio-ecological indicators in ecological restoration has been recently highlighted (see Evju et al. 2020) but they have not been included in wildlife recovery strategies (with the exception of the social benefits of game species). Identifying and demonstrating the benefits of endangered wildlife recovery and habitat restoration to the public and policy-makers may be essential to ensure that funding remains available (Kavousi et al. 2020).

4.4.8 AMBITIOUS AND FUTURE-FORWARD TRANSLOCATIONS

Reintroductions are essential for the recovery of many species and are becoming more critical in a rapidly changing world.

Many of Canada’s most successful species recoveries have involved translocations such as Sea Otter (*Enhydra lutris*) (Fisheries and Oceans Canada 2014) and Trumpeter Swan (*Cygnus buccinator*) (Lumsden

& Drever 2002). Future species recovery in Canada will require conservation translocations to augment populations, increase locations or reintroduce species that have been extirpated.

While translocations are not a panacea for extinction, they have been essential for the recovery of many species around the world (Bolam et al. 2020) and are necessary to increase the number of locations and range for some species. Conservation translocations may also be required to maintain species diversity as climate change rapidly alters the environment (Lee-Yaw et al. 2019). In Australia, climate change is often identified as a threat, but rarely integrated into recovery strategies (Hoepfner & Hughes 2019). The inclusion of climate change as a threat in species assessments is increasing in Canada (Woo-Durand et al. 2020), but direct conservation actions in response to climate change also do not appear in many recovery strategies. Assisted migration to facilitate range shifts and increase locations of species that are vulnerable to the impacts of climate change and other pervasive threats may be necessary for some species to persist. Some species may need to be relocated to novel ecosystems, including urban areas, to maintain populations. Species redistribution science (Bonebrake et al. 2018) is providing new approaches to assess which edge of range species may be critical to support climate change driven range shifts, and which ‘leading edges’ should be targeted for conservation (Gilbert et al. 2019). Maintaining *ex situ* populations of highly threatened species as a component of translocation projects would also provide insurance against loss (Farhadinia et al. 2020).

Despite notable successes, translocations for conservation purposes have not been common in Canada compared to Australia and the US (Dalrymple et al. 2012; Silcock et al. 2019), but are projected to increase (Swan et al. 2018). Low ambition in recovery strategies to implement translocations may also reflect a lack of institutional experience and resources from agencies, a traditional focus on research and monitoring (Buxton et al. 2020) and fear of conservation failure (Meek et al. 2015). In addition, regulators may lack enthusiasm for translocations because of a lack of supportive policies and the potential conflicts with private landowners.

Translocations have resulted in the delisting or down-listing of approximately eight birds, mammals and fishes in Canada. This low number may be a result of agencies first researching threats and habitat needs to inform future translocations, such as current efforts with fishes in the Great Lakes region (Lamothe & Drake 2019; Lamothe et al. 2019).

4.4.9 SPECIES NEED STORIES

By telling the right stories we can engage more people in species recovery and accelerate our efforts.

Most people have a natural attraction to wild species (Wilson 1984) but it is also a learned characteristic (Simaika & Samways 2010). In Canada, and around the world, an increasing number of people are living in urban areas and creating stories that connect people with endangered species conservation is critical. To date there has been a paucity of these stories. Media coverage on climate change is up to eight times higher compared to biodiversity issues (Legagneux et al. 2018).

Our understanding of effective conservation messaging is growing (Kidd et al. 2019) and this supports the emerging field of “translational ecology” (Schlesinger 2010) that seeks to better convey scientific knowledge to the public and policy-makers. Traditional conservation messages may not resonate with people, either because they do not reflect their moral foundation, or the jargon muddles their understanding. Our new ‘biodiversity narratives’ (Louder & Wyborn 2020) need to have a diverse and flexible message toolbox, and that message should change with the audience (Saul 2018). “Boundary objects” (Brand & Jax 2007), such as ecological services (see Bridge 7), can be used to connect with

different groups and bridge moral foundations and interests. Our current storytelling about charismatic species does not need to be replaced but needs an infusion of new stories that reflect the full range and richness of biodiversity. Flagship and endemic species (McGowan et al. 2020; Meuser et al. 2009) can be leveraged to increase public awareness and support, and the “iconization” of poorly known species can also be used to increase public awareness and their willingness to pay for conservation (Rudd 2009).

Personal stories about conservation may be more effective with conservative audiences than scientific facts (Stein et al. 2020). Surveys in Canada and the US show that farmers and rural landowners respond to messages about moral responsibility, stewardship and benefitting future generations (Bonnie 1999; Sherren et al. 2020). Wildlife conservation messages cannot just be based on scientific facts and must be expanded to include compassion, emotion, nostalgia and ecocentric values (Lumber et al. 2017; Taylor et al. 2020; Willson et al. 2019).

4.4.10 SHARE SUCCESS (AND FAILURE)

Canada needs a species recovery forum to share best practices and celebrate our progress.

Despite our current extinction crisis, Canada has a long history of recovering wildlife species. It is critical to build public awareness about extinction, but it is also important to build awareness about species recovery within the public, scientific and conservation communities. An evidence repository of the factors of success (and failure) in recovery could inspire and inform practitioners and ensure we are building on our collective knowledge of best practices (Sutherland et al. 2020) .

Today, recovery stories are most often shared as scattered case studies rather than a regular comprehensive review. Reporting on recovery is outside of the mandate of COSEWIC and will need to be coordinated by the Canadian Endangered Species Conservation Council. The annual reporting previously done by the Recovery of Nationally Endangered Wildlife (ReNEW) program should be reinvigorated to fill this role and support periodic implementation reviews completed by agencies (e.g. ECCC 2018a). Reporting on the patterns and processes of wildlife recovery across taxa and jurisdictions would be a key source of information to inform new recovery strategies and identify factors of success. Systematic reviews and evidence reporting are widely used in the medical field and could help to reduce the science-practice divide in conservation (Walsh et al. 2019). Such a review has recently been prepared on the effectiveness of captive breeding for freshwater fishes and mussels (Lamothe & Drake 2019; Lamothe et al. 2019) and could serve as a model for approaching other technical barriers to recovery.

Although change in the status of a species is a measure of extinction risk and is not necessarily the equivalent of recovery (Akçakaya et al. 2018), it can be a useful measure towards the ultimate benchmark of delisting. In the US, 47 species have recovered sufficiently to be delisted (Langpap et al. 2018). In Canada, 59 species have been delisted by COSEWIC, although only 15 of these (primarily birds) are for genuine reasons (i.e. threat reduction or conservation measures have successfully improved the status of the species) (IUCN 2020). Reporting and analyzing these recoveries could be a useful tool to help understand the anatomy of successful species recovery and barriers to progress. As in the US (Greenwald et al. 2019), Canada has many species that have been recovered because of endangered species laws and actions. These conservation bright spots (Bennett et al. 2016), individually and in aggregate, provide an opportunity to build on best practices, inspire action and showcase the benefits of recovery actions. Our ability to recover species needs to be shared and celebrated. The loss of biodiversity is a significant issue that the public and politicians need to understand. But just as importantly, we need to demonstrate solutions.

4.5 CONCLUSION

The loss of biodiversity is one of the most critical issues facing our planet. Canada has not been immune to the global trend of biodiversity loss. Despite a foundation of good science, supportive legislation, positive public opinion, and many examples of wildlife recovery, we are not bending the curve of extinction.

There certainly are knowledge gaps that we need to address. Every recovery plan has a list of additional research that is needed. There are also important knowledge gaps that we have identified in our bridges. These include refinement in the identification of priority areas, linking ecosystem services to critical habitat and prioritizing edge of range species. But the main limitation of endangered species recovery is not a question of what to do, but how to do – how can we mainstream and accelerate current efforts to a pace and scale that matches, and then exceeds, the rate of biodiversity loss? Our current state of extinction and the rapid pace of ecological change necessitate both rethinking our traditional strategies to conservation and testing new transformative strategies.

The ten bridges we propose here can help to improve the effectiveness of recovery and bend our trajectory of wildlife extinction to recovery. Our focus of these bridges is on Canada, but the ideas and solutions we identify can be adapted to a wide range of other contexts and countries. These bridges are intended to support efforts that span the ‘knowing-doing’ gap (Pfeffer & Sutton 1999). Some bridges require only modification to current practices, while others need major changes in approaches and institutions. This transformation requires an extension beyond traditional practices and must integrate and normalize nature conservation into our society and culture.

Ecosystem approaches can shift our thinking from species recovery to ecosystem recovery. Ecological services can help society to better understand the full value of nature’s services. Community governance and flexible implementation can engage diverse actors in recovery. Sharing past success can help to inspire more ambitious conservation efforts. Species conservation that meets a broad array of interests and values will lead to more enduring outcomes. Calibrating and communicating our wins and losses is important for assessing the effectiveness of actions and building support from the public and decision-makers.

Canada has many examples of successful wildlife recovery; from the reintroduction of the Swift Fox (Herrero et al. 1986) to the recent delisting of the Peregrine Falcon (*anatum/tundrius* subspecies) after 39 years on the endangered species list (COSEWIC 2017b). An understanding of wildlife biology and thoughtful application of conservation science were needed for this work. But the essential component of these successes has been the result of small groups of people that were impassioned and empowered to act. The recovery or extinction of species in Canada has foundations in biology and threats, but the fate of a species may ultimately be decided not by more science or government policies, but by transforming our values about wildlife, our perceptions about conservation, and inspiring a new generation to act.

CHAPTER 5. FAILING TO PLAN OR PLANNING TO FAIL? A SURVEY OF RECOVERY PRACTITIONERS ON THE CHALLENGES AND OPPORTUNITIES TO ACCELERATE SPECIES AT RISK RECOVERY IN CANADA

This chapter was written by the author with support from: Dr. Stephen Murphy (survey questions, ethics approval, review draft), Dr. Andrew Drake (DFO) (survey questions, review draft, survey distribution), Christie Whelan (ECCC) (survey questions, survey distribution), Trevor Swerdfager (survey questions), and Dr. Jeremy Pittman (review draft).

Although this chapter contains some links to previous chapters, it has been written as manuscript with the intent of publication and uses plural first-person pronouns.

Abstract

Our paper presents the results of the first comprehensive survey of recovery planning practitioners and experts in Canada. The objectives of the survey are to identify current challenges in species at risk recovery planning and implementation, and to identify new opportunities to accelerate recovery. Canada currently has over 700 species listed under the *Species at Risk Act* and over 500 federal recovery documents, but few wildlife species have improved in conservation status since the *Act* came into force in 2002. The 136 respondents to the survey were from across Canada and have worked on all taxonomic groups. Collectively, the respondents represented over 1000 years of experience in developing species at risk recovery documents. While over half of respondents predicted recovery documents would improve the status of species, less than 5% expect that recovery documents will be fully implemented. Respondents prioritized species at risk of global extinction the highest, and species within protected areas or conserved through other legislation the lowest. Opportunities for improvement in the development and implementation of recovery documents included more effective consultations, including co-production with Indigenous communities, streamlining planning processes and documents, and improved sharing of best practices to recovery. After two decades of Canada's *Species at Risk Act*, there is a critical need to shift focus from planning to effective implementation to fulfill the *Act's* purpose.

5.1 INTRODUCTION

The rapid decline of wildlife populations and species diversity is a global crisis. Extinction rates are up to one thousand times greater than historical levels and future rates are projected to increase (De Vos et al. 2015; May & Lawton 1995). Globally, over 44,000 species are now assessed as threatened (IUCN 2023b) and up to one million species are at risk of extinction in the coming decades (Díaz et al. 2019; Tollefson 2019).

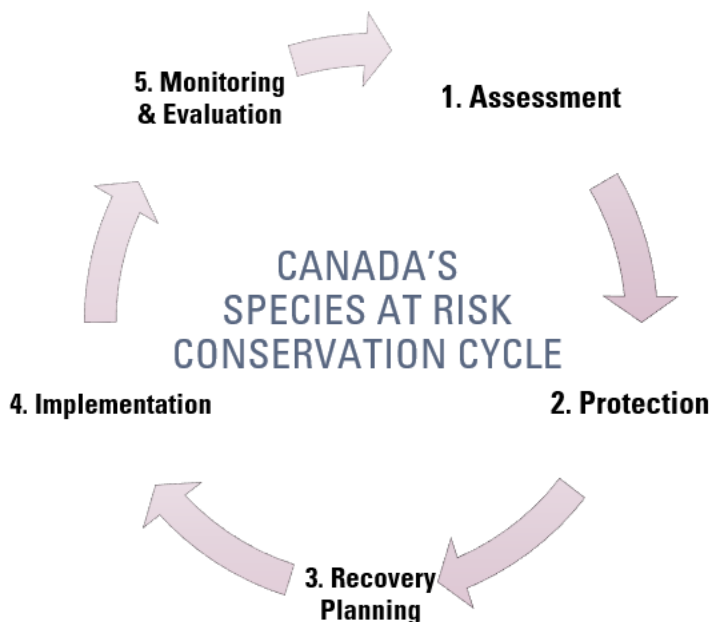
Despite its large size and vast of areas with high ecological integrity (Watson et al. 2018), Canada has not been immune to the global extinction crisis. One in five species that have been assessed are at some level of risk (CESCC 2022) and over 700 species are now listed under Canada's *Species at Risk Act* (SARA) (2002). SARA is part of *Canada's Biodiversity Strategy* (Environment Canada, 1995); the federal response after ratifying the United Nations Convention on Biological Diversity (CBD) in 1993. This international treaty brought biodiversity into the sphere of federal jurisdictional interest. In Canada federal interest in

nature is restricted by the constitutional division of powers (Campbell & Thomas 2002). The federal government has very limited jurisdiction in the provinces, and can only protect migratory birds, aquatic species, and species found on federal lands (e.g., national parks, national wildlife areas). All other species and the areas they reside in fall under the jurisdiction of the provinces and territories.

Federal responsibilities of SARA lie within three different departments. The Ministry of Environment and Climate Change (ECCC) is responsible for the overall coordination of the federal species at risk strategy and the protection and recovery of migratory birds. Fisheries and Oceans Canada (DFO) is responsible for the protection and recovery of aquatic species at risk under federal jurisdiction. Parks Canada Agency is responsible for the development of recovery strategies for those species that primarily occur in national parks, national historic sites, and other federally protected and conserved areas.

SARA maintains a formal separation between species assessments, listing, recovery planning, protection, and monitoring and reporting (**Figure 13**) (ECCC 2018a). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wildlife species (including subspecies, varieties or other designatable units) that are suspected of being at risk of extinction or extirpation. The federal government then decides if species assessed as at risk will be listed under SARA. Once listed, the species receives legal protection afforded and mandatory recovery planning required under SARA.

Figure 13: Canada's Species at Risk Conservation Cycle



Recovery planning is an important aspect of SARA. It is designed as a collaborative process that involves the federal government, provincial and territorial governments, Indigenous peoples, and stakeholders. There are three types of recovery documents that are prepared under SARA. For species listed under SARA as extirpated, endangered, and threatened, a *recovery strategy* is prepared. A recovery strategy includes a determination of whether recovery is feasible. If recovery is determined to be feasible, the recovery strategy must address threats to the survival of the species that were identified by COSEWIC. It must also include other specific elements as outlined in SARA section 41 including population and distribution objectives. The recovery strategy sets out the measures that will be taken to address the threats to the species and promote its recovery. These measures may include habitat restoration,

population management, research, and monitoring. The recovery strategy also includes a timeline for the implementation of these measures and an evaluation plan to track progress towards the recovery goals. A proposed recovery strategy must be posted on the Species at Risk public registry within one year of listing on for endangered species, and within two years for threatened or extirpated species.

A *management plan* must be prepared within three years of listing for a species of special concern. This recovery document must include measures for the conservation of the species. A management plan differs from a recovery strategy, as it sets goals and objectives for maintaining sustainable population levels of one or more species that are particularly sensitive to environmental factors, but that are not in danger of becoming extinct or extirpated.

In addition to recovery strategies for species that are listed as endangered or threatened under the Act, SARA also requires the development of one or more *action plans*. Action plans provide more detailed guidance on the specific measures to implement the recovery strategy and to meet the recovery objectives.

SARA (section 69) allows the Minister to adopt all or part of an existing recovery document for a species at risk if the Minister is of the opinion that the document includes adequate measures for the conservation of the species. For example, the management plan for the Threaded Vertigo (*Nearctula* sp.) was prepared by the province of BC and then adopted by the federal government. Once the recovery strategy or management plan has been developed or adopted, it is published on the Species at Risk Public Registry, and a period of public comment follows. The final recovery document is then posted on the registry and becomes a legally binding document under SARA.

Under SARA, the federal government is responsible for implementing recovery documents, in collaboration with other jurisdictions and stakeholders. The federal government also funds recovery efforts through programs such as the Habitat Stewardship Fund and Canada Nature Fund. SARA also requires the competent ministers to report on the implementation progress of recovery strategies (but not management plans) within five years of the date when the final recovery strategy was placed on the Species at Risk Public Registry. Reporting continues in every subsequent five-year period, until the recovery strategy is no longer required under SARA or the species' recovery is no longer feasible.

The complex web of federal, provincial, and territorial species at risk responsibilities and reporting, combined with a growing number of species at risk and limited and fluctuating funding creates challenges to developing effective recovery documents and implementing actions. Recovery planning is a critical component of SARA and is the foundation for actions to reduce extinction risk (**Figure 13**). As presented in **Chapter 4**, SARA has been criticized for the time it takes for recovery documents to be prepared (Ecojustice 2012; Mooers et al. 2010). An audit in 2013 by the Office of the Auditor General of Canada (OAG) found that 146 of 360 (40.5%) recovery strategies were overdue (OAG 2013). However, by 2022, the OAG found that just 10% of the 627 species listed as extirpated, endangered, threatened, or of special concern did not have recovery strategies or management plans in place as required by the Act (OAG 2023). However, more than half of the action plans needed to support recovery had not been developed and over 200 implementation reports are overdue for recovery strategies of threatened, endangered, and extirpated species (OAG 2023).

While there has been laudable progress in delivering over 500 recovery documents under SARA, 80% of species at risk that have been reassessed show no change or declining conservation status (ECCC 2023a). In addition, many of the improvements in conservation status are due to non-genuine reasons and status improvements for genuine reasons (i.e., conservation actions) primarily occurred in the absence of recovery documents (**Chapter 2**). Continuing to enhance effective recovery planning and action is

critical for reducing extinction risk of Canada’s wildlife and meeting Target 4 of Canada’s 2030 Nature Strategy (ECCC 2024a).

Our paper presents the results of the first comprehensive survey of recovery planning practitioners in Canada. While there have been many critiques and assessments on how to improve recovery planning (e.g., Smart Prosperity Institute 2018) our approach was to solicit advice from actors that are directly involved in writing, implementing, and assessing recovery documents. The objectives of the survey are to identify practitioner perceptions of the current challenges of SARA recovery planning, and to identify new opportunities to accelerate recovery.

5.2 METHODS

To identify perceived challenges and opportunities of species at risk recovery planning in Canada we developed and distributed an electronic survey. The survey was developed by the authors based on a literature review of barriers to species at risk recovery (Kraus et al. 2021) and reviewed by ECCC and DFO experts involved in recovery planning, including from DFO and ECCC. This study was reviewed and received ethics clearance through a University of Waterloo Research Ethics Board [44054]. Targeted actors were identified by the authors and ECCC to complete the survey which focused on individuals and groups involved in the development, review, or implementation of species at risk recovery documents. The 15 survey questions are provided in **Appendix 2 - Supplementary Information (S1)**.

The survey was distributed electronically via Qualtrics (Qualtrics, Provo, UT) between November 21-24, 2022, to 109 recovery plan practitioners and agencies including species at risk biologists in ECCC, DFO, and Parks Canada and to COSEWIC (**Table 25**). Recovery plan practitioners were asked to personally distribute the electronic survey to relevant staff in their agency, and the email containing the survey link described our target actors. To increase the response rate, we sent a reminder email to actors on the original distribution one week before the survey closed and posted the link in Twitter (now X) and LinkedIn. We estimate that approximately 500 actors received the survey, however the exact sample size is unknown because some agencies distributed the survey through email listservs.

Table 25: Survey timeline (2022)

November 21	Email distribution to 109 experts. Experts encouraged to share survey with colleagues having relevant expertise. At least one expert shared the survey link on Twitter.
November 22	Request to DFO and PCA to distribute the survey internally to employees with relevant expertise.
November 24	ECCC distributes internally to 150 employees with relevant expertise.
December 16	Reminder to complete survey sent to experts on original distribution list.
December 20	Posted on Twitter (1,330 Impressions) & LinkedIn (1,645 Impressions).
December 23	Survey closed.

Questions 1 to 7 were designed to collect demographic information on the respondents including region of work, role in recovery planning, taxonomic expertise, organization, professional experience in years and number of recovery documents, and contributions to species assessments. Questions 8 and 9 focused on respondents' perceptions of the conservation impact and implementation of recovery documents. The next two questions (Questions 10 and 11) asked respondents to rank options on how to improve the process, implementation, and effectiveness of species at risk recovery documents, and provided opportunity for open text responses. Question 12 asked about how species should be prioritized for recovery planning with limited resources and Question 13 explored how to measure species at risk recovery. Question 14 allowed respondents to provide any other suggestions to improve recovery planning. The final question of the survey (Question 15) asked respondents to provide any additional information that was not covered in the previous questions.

Twelve of the survey questions were multiple choice to categorize the demographics of the respondents and responses to the questions. Three of the questions (Questions 10, 11, 12) used a Likert scale (highest, medium, lower, not sure) to determine the perceived impact or priority of the options in multiple choice questions. These were scored on a scale from 1 (highest) to 4 (not sure) and the mean was used to identify the top selections. Where applicable, multiple-choice questions provided an 'other' category for respondents to share an answer that was not provided, including short-form descriptions of additional information. The last two questions of the survey were open-ended and intended to solicit additional feedback on the questions or topics not covered in the survey.

Multiple choice questions with only one response that could be selected were analyzed using the count of total responses and the percentage of responses per option in Qualtrics. In addition to a count of selected categories for the Likert scale questions, mean and standard deviation were calculated for questions involving quantitative information. Categorical analysis for select questions employed Crosstabs iQ pairwise statistical tests within the Qualtrics platform to examine relationships between selected variables. Variables relevant to the study's objectives, such as respondent demographics (e.g., region, agency), characteristics related to species at risk recovery planning (e.g., taxonomic expertise, years of experience), and predictions on the outcomes of recovery documents were identified for analysis. Crosstabs iQ facilitated the created contingency tables to visualize and analyze the frequency distributions of responses across these selected variables. Pairwise statistical tests, conducted at a 95% confidence level, were then utilized to assess the significance of associations between pairs of categorical variables, employing chi-square tests.

The open-ended responses from the survey underwent manual coding using inductive categories (Thomas 2003). Initially, all responses were thoroughly reviewed to gain familiarity with the content and context of each statement. Each response was coded, with codes assigned to segments that captured distinct ideas or concepts. These initial codes were then grouped into preliminary categories as similarities and patterns emerged across the dataset. Through iterative comparison and refinement, broader themes were identified, reflecting recurring patterns and insights in the responses. Detailed documentation throughout the coding process ensured transparency and consistency in decision-making, culminating in the finalization of comprehensive categories and themes. This methodological approach facilitated a thorough and systematic analysis of the challenges and opportunities in species at risk recovery planning, grounded in the qualitative insights provided by respondents. This approach is widely recognized in qualitative research for its systematic and rigorous method of analyzing qualitative data to derive meaningful insights and understandings.

5.3 RESULTS

5.3.1 WHO RESPONDED?

There were 136 respondents that completed the survey. There was a 100% response quality in Qualtrics indicating that the survey response was fully completed with thoughtful answers, adequate time spent, and no signs of inattentive or fraudulent responses. Every province and territory had at least one respondent, with the majority describing the region where they primarily work on species at risk recovery as National (36.8%), Ontario (32.7%), British Columbia (21.0%), and Alberta (15.9%) (**Question 1**, 119 responses). The regions with the lowest response were Nunavut (2.5%), Prince Edward Island (3.3%), and New Brunswick (4.2%). Most of the respondents identified their roles as a contributor to recovery plan documents (63.5%), recovery document author (48.3%), or a practitioner that implements recovery documents (45.7%) (**Question 2**, 118 responses). Respondents reported a wide diversity of expertise across taxonomic groups. At over 30% each, terrestrial mammals, birds, and vascular plants were the groups with the greatest reported expertise. All other groups were between 10-30%, except for marine fishes (9.5%), lichens (3.4%), and mosses (1.7%) (**Question 3**, 115 responses). Over half of the respondents (60 responses) reported expertise with more than one taxonomic group, with 44 different combinations, including 20 respondents that reported expertise in three or more groups. Respondents with expertise in multiple taxa ranged from groups that can be associated through habitats (e.g., freshwater fishes and molluscs, n=7) to groups with more disparate associations (e.g., birds, reptiles, vascular plants, n=1). Six respondents reported working across taxa that are the responsibility of DFO and ECCC (e.g., arthropods, birds, freshwater fishes). Most respondents worked for the federal government (44.4%), provincial/ territorial government (18.8%), non-governmental organizations (11.1%), academia (11.1%), and consulting/self-employed (10.2%) (**Question 4**, 117 responses).

There was a wide diversity in the professional experience of respondents. Most have been involved in species at risk documents for 11-20 years (31.0%) and under 5 years (29.3%) (**Question 5**, 116 responses). The remaining respondents reported involvement in species at risk recovery documents for 6-10 years (23.3%) and over 20 years (16.4%). The average number of recovery documents respondents have been an author or contributor to is 11.8 (**Question 6**, 113 responses). Most respondents (23%) reported that they have authored or contributed to 6-10 recovery documents. Just 13% of respondents reported that they have not authored or contributed to recovery documents. Collectively, the respondents represent over 1,000 years of experience in species at risk recovery documents and have collectively authored or contributed to over 1,331 recovery documents. These numbers are a minimum as some respondents reported the highest category of years of experience (Question 5) as 30+ years or qualified the number of documents they have authored or contributed to with 'over', 'more than', or '+'. The final question that focused on the respondents examined their contributions to species assessments. (**Question 7**, 115 responses). Over half of the respondents (56.5%) reported that they have also contributed to COSEWIC assessments as a COSEWIC member, report writer, or reviewer.

5.3.2 PREDICTED IMPACT OF RECOVERY DOCUMENTS

Over half (55.7%) responded that that full implementation of recovery documents would result in reassessment of the species into a lower risk category (**Question 8**, 104 responses). Just under 29% predicted that full implementation would maintain the status quo, while 15.3% predicted that even with full implementation the status of the species would decline. There was a statistically significant

difference in the responses of mollusc and vascular plants experts. Mollusc experts were more likely to predict decline and vascular plant experts were more likely to predict status quo.

Two-thirds (67.6%) expect that recovery documents will be partially implemented and 27.6% expect that recovery documents are unlikely to be implemented (**Question 9**, 105 responses). Less than 5% of respondents expect that recovery documents will be fully implemented. There was a statistically significant difference between the three agencies with the largest response rate. While only 13.0% of federal government respondents expected that recovery documents are unlikely to be implemented, almost half (45.5%) of provincial agency and 38.5% of academic respondents shared these low expectations for implementation.

5.3.3 HOW CAN RECOVERY PLANNING BE IMPROVED?

Question 10 (106 respondents) focused on opportunities to improve the process of preparing recovery documents. Options selected as having the highest impact to improve the process of preparing a recovery document (based on the mean, see **Appendix 2 - Supplementary Information, S2**) were: more funding to identify critical habitat and fill research gaps (48.5% selected as highest impact), combining recovery documents with action plans (42.2% selected as highest impact), more input from species experts (24.2% selected as highest impact), and more effective consultations with Indigenous communities (29.5% selected as highest impact). There were also 31 open text answers provided by respondents. These text responses also partially addressed Question 11 and focused on reducing delays in planning, streamlining content, increasing accountability through clear and numerical recovery targets, and using recovery teams (including multidisciplinary and Indigenous participation) to develop recovery documents.

While Question 10 was about the planning process, **Question 11** (105 respondents) addressed how the implementation and effectiveness of recovery documents could be improved. The top five options (based on the mean, see **Appendix 2 - Supplementary Information, S2**) selected were: more resources for implementation (84.5% selected as highest impact), more focus on threat abatement (78.6% selected as highest impact), improved linkages between funding programs and recovery actions (68.0% selected as highest impact), increased focus on evidence-based actions (59.2% selected as highest impact), and more specific and measurable objectives and strategies (51.5% selected as highest impact). There were also 28 open text answers that respondents shared with common themes of increased funding and enforcement, greater political will and interagency cooperation, more emphasis on incentives, and more specific and actionable recovery documents. Open text that addressed the process of developing recovery documents (Question 10) included greater coordination with COSEWIC and defining protected critical habitat.

5.3.4 WHAT ARE THE PRIORITY SPECIES?

Question 12 (105 respondents) asked about how species should be prioritized for recovery planning with limited resources. The top options that were selected (based on the mean, see **Appendix 2 - Supplementary Information, S2**) were: species at greatest risk of global extinction (80.0% selected as highest impact), species that are likely to benefit other species when recovery plans are implemented (64.4% selected as highest impact), nationally endemic species (61.2% selected as highest impact), and species most likely to benefit from recovery actions (57.7% selected as highest impact). Species within protected areas or conserved by existing legislation scored the lowest and less than 5% of respondents indicated that these groups should be a high priority. Open text responses (n=18) included prioritizing

culturally significant species, jurisdictional responsibility, and species that are declining rather than species that are rare.

5.3.5 HOW DO WE MEASURE PROGRESS?

Most respondents to **Question 13** (105 respondents) (57.1%) selected population trends that are consistent with objectives identified in recovery documents. Almost 30% of respondents selected that recovery should be measured by an improvement in COSEWIC status, with 22.9% choosing only genuine improvements, while 6.7% would measure recovery though any improvement in status (i.e., including the discovery of new populations). Open text responses (n=14) suggesting other options included combining a change in COSEWIC status with population objectives (n=5). Other suggestions included applying the IUCN Green List (Grace et al. 2021), population trends in protected lands, and incorporating additional Indigenous knowledge. Two of the respondents noted that clear recovery objectives and species-specific metrics need to be included in recovery documents (Question 11).

5.3.6 OTHER SUGGESTIONS TO IMPROVE RECOVERY PLANNING

Question 14 (54 responses) allowed respondents to provide any other suggestions to improve recovery planning. Overall, the suggestions focus on improving the efficiency and effectiveness of recovery planning, enhancing accountability and monitoring, and providing adequate funding for recovery efforts. We categorized the suggestions into the following eight topics:

1. **Alignment of SARA and COSEWIC:** This topic includes suggestions on aligning COSEWIC species prioritization with the purpose of SARA, linking recovery with status assessments, and engaging with provincial and territorial governments throughout the SARA species at risk conservation cycle. It also includes suggestions for providing recovery advice earlier in the SARA cycle.
2. **Accountability and monitoring:** This topic includes suggestions on accountability once recovery strategies are posted, avoiding repetition of science summaries in recovery plans, annual reporting by each jurisdiction, selective use of critical habitat as a priority, and better consultation during listing phase on the impact of listing. It also included suggestions to increase funding for reporting on SARA.
3. **Standards and frameworks:** This topic includes suggestions for applying the Conservation Standards or Open Standards as the single framework for designing recovery documents.
4. **Funding:** This topic includes suggestions for funding knowledge gaps to reduce assumptions made by COSEWIC and providing adequate funding for implementing recovery plans.
5. **Ecosystem-based recovery:** This topic includes suggestions for focusing primarily on ecosystem-based recovery.
6. **Tailoring recommendations:** This topic includes suggestions for tailoring recommendations to jurisdictions, including the threat calculator, and recognizing a 'watch-list' for species that are at risk but would not benefit from increased regulation.
7. **Use of academic research:** This topic includes suggestions for more effectively harnessing academic research.
8. **Detailed direction for implementation:** This topic includes suggestions for providing more detailed direction on how to implement key actions in recovery plans.

The final question of the survey (**Question 15**, 45 responses) asked respondents to provide any additional information that was not covered in the previous questions. Responses were a mix of new information and reinforcement of answers to previous questions. Overall, the five themes that emerged included improving the development process of recovery documents, focusing on threats, identifying

specific population targets, increasing the scientific focus, and new collaboration approaches. Other considerations included cost-benefit analyses and ecosystem approaches.

1. **Streamline the development process of recovery documents:** This topic includes suggestions to streamline content among recovery documents, maintain standard wording in a template, and reduce changes recovery document templates. There was also a call for faster review and approval process, to increase recovery planning capacity, and to better link recovery documents to implementation.
2. **Greater focus on threats:** This topic included calls for a stronger focus on the drivers of extinction risk (i.e., threats) and less on the symptom of declining species populations. There was also discussion on how the mitigation hierarchy could apply to species or groups of species to identify mitigation and offset measures and highlight which habitats and species cannot be mitigated or offset.
3. **Population targets:** This topic included suggestions to identify specific and numerical population targets, actions to achieve the target, and how to monitor populations to measure success. The need for more detailed planning at the local population scale was also highlighted, because recovery documents tend to assess threats and strategies that are generalized to the entire population.
4. **Scientific Focus:** This topic highlighted that recovery documents need more focus on science and less focus on administration and policy. This will require more investment in surveys, monitoring, and research prior to COSEWIC assessments.
5. **Increased collaboration:** This final topic calls for more collaboration among groups for strategic development and implementation of recovery documents. This includes the co-management and co-development recovery documents with Indigenous governments and organizations, rather than simply consulting.

Overall, the responses to the last two questions emphasized the need for more streamlined and efficient processes, greater focus on science, and collaboration among groups. There was also a call for more detailed planning, the incorporation of Indigenous knowledge, and a broader ecosystem approach to recovery actions. Finally, there was a desire for more funding and resources to support these efforts, including increased staffing of qualified biologists.

5.4 DISCUSSION

Our survey sought to better understand the perceptions of species at risk recovery plan practitioners, identify current challenges in the recovery planning process, and to generate new approaches to improve the process and effectiveness of species at risk recovery in Canada. Based on the responses to the survey questions, we identify three key challenges that are focused on implementation, species prioritization, and measuring impact. Respondents also highlighted six opportunities that can be applied to improve recovery planning. These include improving collaborations and approaches, streamlining the development of recovery documents, setting more specific targets, greater focus on threats, improved reporting and adaptive management, and pivoting more quickly from recovery planning to action.

5.4.1 CHALLENGES IDENTIFIED BY SURVEY RESPONDENTS

Challenge 1: The big implementation gap

Respondents clearly recognized that more resources are needed for the implementation of recovery documents (**Question 11**). **Questions 8 and 9** also highlight a key implementation gap in recovery

documents. Respondents were quite optimistic that species at risk recovery strategies, management plans and action plans would improve the status of species if they were fully implemented. This is despite limited evidence of genuine species recovery (ECCC 2023a, **Chapter 2**) and that past criticisms indicting that recovery strategies often lack ambition (Pawluk et al. 2019). The responses may be based on an assumption of long-term mitigation of threats. Recovery documents generally acknowledge key threats, including large-scale pervasive threats, such as high turbidity in aquatic systems in agricultural landscapes or loss of native grasslands. While successful mitigation of these identified threats would likely improve status, implementation will need to be long term sustained recovery efforts.

Respondents also recognize implementation challenges. One of the key findings of the survey is that less than 5% of respondents expect that recovery documents will be fully implemented. This points to a significant implementation gap between planning and action in Canada and brings the very purpose of recovery documents to question if recovery documents are prepared and not implemented (**Box 5.1**). The SARA implementation gap widens when compounded with the delays in listing species and preparing recovery documents. The drivers of this low confidence of implementation were not directly explored in the survey. Greater pessimism by provincial and academic respondents compared to federal actors that recovery plans would be implemented may result from their more direct on-the-ground engagement in recovery actions and tracking progress.

Box 5.1: Responses on the implementation gap in recovery planning

‘...more focus on details of HOW to implement recovery actions, considering both logistical and financial barriers that often prevent effective implementation.’ (response to Question 11)

‘Getting to action plans is a major challenge. There are 86 action plans in the registry, 23 of them are for Parks Canada parks, another several are for species with very limited range like one lake or a few remnant habitat areas, so we may have 50 meaningful action plans 20 years after SARA was passed in parliament. I would call that a failure.’ (response to Question 14).

Challenge 2: Prioritizing species for recovery

Prioritizing species for conservation action is a fundamental question in the field of conservation biology (Groves et al. 2003). While COSEWIC or Red List assessments prioritize extinction risk, they do not prioritize recovery feasibility or actions. There are three primary opportunities under SARA to prioritize species for recovery: 1) species selected for COSEWIC assessments, 2) listing under SARA and preparing recovery documents, 3) priorities identified in funding programs including the federal Habitat Stewardship Fund and funding to priority species and priority places (ECCC 2018b). Results from the survey on the highest priority species for recovery planning (**Question 12**) supports calls to prioritize species that are at global risk of extinction and nationally endemic (Klemet-N’Guessan et al. 2019; Kraus et al. 2023; Raymond et al. 2018). COSEWIC prioritization does incorporate global status and jurisdictional responsibility (COSEWIC 2022), and those priority groups can be elevated through the assessment process. However, only one-third of Canada’s nationally endemic species have been assessed by COSEWIC (Kraus et al. 2023) and 15% of species of global conservation concern are listed under SARA (NatureServe 2023).

Other high priorities for assessment identified by respondents included species with the highest threats and species with recovery actions that will benefit other species. Text responses included the prioritization of threats based on feasibility, probability of success, and impact across multiple species (**Box 5.2**). Both COSEWIC assessments and recovery strategies now include a systematic approach to threats assessment (Salafsky et al. 2008). While threats have been summarized across species at risk (e.g., Currie et al. 2020), threat-based prioritization has only been applied to a few regions of Canada

(Camaclang et al. 2021). Similarly, while recovery documents recognize the ‘effect on the environment and other species’ and conservation actions can also be categorized (Salafsky et al. 2008), there is currently no prioritization of species recovery actions that would benefit multiple species.

Box 5.2: Responses on priority setting

‘I think threat mitigation should be prioritized, the more species a threat impacts, the higher the priority to work to mitigate it.’ (response to Question 12)

‘Triage approach-assessing priority based upon multiple criteria in the context of similar species or species groups to determine where allocation of resources should go.’ (response to Question 12)

‘Species most likely to recover, species with easily implemented actions, species where regional experts/communities are already on the ground ready to go.’ (response to Question 12)

Species within protected areas or conserved by existing legislation ranked the lowest and less than 5% of respondents indicated that these groups should be a high priority. Unlike the US where the adequacy of existing regulatory mechanisms is a listing criterion under the *Endangered Species Act*, current protections are not a key factor in the selection of species for assessments, status assessment, and listing in Canada, although a few species that have been assessed have had status modifiers applied that change the status based on existing protections (e.g., Blunt-lobed Woodsia [*Woodsia obtusa*], Willowleaf Aster [*Symphotrichum praealtum*]). As identified by one respondent, recovery planning for species, even for species of global conservation concern, within existing protected areas can direct resources away from species in greater need (**Box 5.3**).

Box 5.3: Responses on prioritizing species within existing protected areas

‘The endemics question is a tough one – we’ve seen a number of endemic arthropods on Sable Island assessed as E (endangered) solely because they occur in one location – it doesn’t seem to be taken into account that the island has some of the highest protections in place in Canada. It takes resources to plan for these species – that could be better used elsewhere’ (response to Question 12)

Challenge 3: Measuring success

The purpose of SARA is to recover wildlife species at the greatest risk of being lost from Canada and to manage species of special concern to prevent them from becoming endangered or threatened. Despite several frameworks to measure recovery (e.g., Burgess et al. 2019; Grace et al. 2021; Westwood et al. 2014) tracking progress is a challenge given the diversity of species at risk, jurisdictional responsibility, threats, conservation actions, and temporal scales of response. Most respondents to **Question 13** support that the current indicators of species at risk population trends (ECCC 2023c) and change in the status of wildlife species at risk (ECCC 2022a). While only 20% of respondents reported that genuine status change should be measured, this concept is newer to Canada compared to IUCN assessments (**Chapter 2**). However, one respondent detailed why non-genuine status changes should not be used to measure recovery success (**Box 5.4**).

Box 5.4: Responses to measuring recovery success

'... For certain taxa (eg. Lepidoptera and plants that are difficult to identify) the COSEWIC status is based on very limited data. Often, after several years of targeted surveys by ECCC staff, new populations are discovered and the species is downlisted. That is not doing conservation work and that is not how recovery should be measured. ECCC should invest more money in early pre-assessment population status surveys for species that lack data, specifically for obscure species or taxa, avoiding the need to develop RS [recovery strategy] and ID CH [identify critical habitat] which takes a lot of time, money and involves a high level of consultations with jurisdictions and other agencies. It just makes no sense to list species, develop RD [recovery document], and then downlist them only because new populations were discovered. A lot of money and human resources could be saved if the federal gov invested money early on. We would definitely have less species listed.' (response to Question 13)

In the open text responses, six respondents suggested that multiple or customized measures should be developed (**Box 5.5**).

Box 5.5: Responses on measuring species recovery

'Any measure that is a reliable indicator of genuine improvement is defensible. In many cases, provincial recovery goals are so vague that the concept of consistency applies only loosely.' (response to Question 13)

'Could vary from range expansion to abundance - depending on what makes sense/is practical to measure for the species.' (response to Question 13)

There was a difference in agency response regarding the importance of reporting on success (option in **Question 11**). While 86.4% of provincial respondents answered that more reporting on recovery document progress was a high or medium priority, 46.2% of federal respondents answered that this reporting is a lower priority. This difference may be both a cause and effect of the large backlog of implementation reports currently faced by ECCC (with only one of 399 required implementation reports completed) (Office of the Auditor General of Canada 2023). Provincial actors may be more engaged in on the ground recovery and are seeing progress that they want to be recognized.

5.4.2 OPPORTUNITIES TO ENHANCE RECOVERY PLANNING IN CANADA

Results of our survey provide a snapshot on the state of play of recovery planning in Canada and can be used to inform many aspects of species at risk recovery including priority setting and measuring progress. The main objective of this survey is to identify opportunities to enhance approaches to the recovery of wild species at risk. Based on the results of the survey, and in particular responses to **Questions 10, 11, 14 and 15**, we have identified six opportunities that can be used by recovery document planning and implementation practitioners and decision-makers to support recovery efforts.

Opportunity 1: Increase collaboration

One of the central themes in the survey was the need for increased collaboration and respondents had suggestions for many different levels and types of collaboration. This includes greater collaboration and connections between COSEWIC and recovery planning, federal, provincial, and territorial agencies, recovery documents and funding programs, and recovery planning and Indigenous communities. At its core, SARA was based on the principle of government collaboration through the *Accord for the Protection of Species at Risk*. While there is coordination between the federal government and

provincial and territorial governments, there are barriers that limit the full range of collaborative partnerships needed to develop and implement recovery strategies. Given the limited authority of the federal government for species at risk (**Box 5.6**) collaboration and partnerships between federal, provincial, territorial governments, private landowners, and Indigenous communities are essential for species at risk recovery. Nature Agreements between the federal government and provinces/territories, and priority places and sectors offer a collaborative mechanism, however they exclude many species at risk and potential conservation partnerships.

Box 5.6: Responses on the need for increased collaboration

‘One of the biggest problems in Canadian SAR [species at risk] recovery is the minuscule amount of land that the feds can direct money to action. Less than 8% of SAR critical habitat falls on federal land, making it problematic to fund action. Need more partnerships to make a big difference.’ (response to Question 15)

‘In many cases, national recovery plans can only be implemented at the provincial or territorial level. ECCC and DFO also have to realize and respect the important roles that partnering provinces/territories have in making recovery happen.’ (response to Question 15).

Increased collaboration could be supported through provincial and territorial species at risk action plans and Key Biodiversity Areas (KBAs) (IUCN 2016). Both the planning and funding approaches for action plans could be modeled after *State Wildlife Action Plans* in the US and be used to develop agreed upon priority species and actions within each province and territory. Nature Agreements offer an existing mechanism to clarify species at risk objectives and shared roles but need more detail. While provincial and territorial action plans provide a jurisdictional scale to prioritize actions, KBAs offer a local scale to develop collaborative implementation plans and actions. KBA Canada is in the process of identifying and mapping the most important places for species at risk, but also globally threatened species, range restricted species, threatened ecosystems, and wildlife congregations. Both provincial and territorial action plans and community-based planning and action within KBAs also foster approaches to preemptive conservation by identifying actions for species that are likely to be at risk if assessed by COSEWIC and in supporting ecosystem-based approaches to recovery (see **Opportunity 4**).

Greater engagement and consultation with Indigenous communities was identified as a key need to increase collaboration in developing and implementing recovery documents. There was a recognition that Indigenous communities are consulted in recovery documents, but that this should move to an approach that fosters the co-production of recovery documents and implementation actions (**Box 5.7**). There are emerging knowledge co-production approaches in species assessments (e.g., Singer & Lee 2021) that could be applied to recovery documents.

Box 5.7: Responses on the need for co-production of recovery documents with Indigenous communities

‘Respectfully use Indigenous and Community knowledge throughout the SAR process (assessment, listing, recovery planning); this builds relationships and trust with the people implementing actions to recover species. No matter how effective consultation is – it is still limiting. To consult is merely to seek information or advice. When you co-manage species and co-develop recovery plans then the responsibility to recover species is shared.’ (response to Question 14)

‘Recovery planning does a very poor job of incorporating Indigenous Knowledge. Mostly, it is included as subsections in relation to Western Science. This has to change. Moving away from just copy and pasting to collaboration.’ (response to Question 14)

Other recommendations for collaboration identified in the survey are increased engagement of species experts. One of the challenges identified by respondents was that species experts often don't have time to review recovery documents. However, our survey shows that over half of the respondents (56.5%) reported that they have also contributed to COSEWIC assessments as a COSEWIC member, writer, or reviewer. In the US and Australia, the scientific bodies that assess species risk are also involved in the approval of recovery plans. While the SARA species at risk conservation cycle differentiates between assessment and recovery planning (**Figure 13**), many of the same experts are involved in both. Recognizing this overlap and finding opportunities for species experts to provide feedback into recovery actions during assessments could create efficiencies and identify key recovery actions earlier in the SARA species at risk conservation cycle.

The survey also identified the important role of recovery teams and the current lack of resources and coordination. Many recovery documents are prepared by consultants with a limited budget and are not developed by multidisciplinary teams (**Box 5.8**). Funding programs that provide both capacity building and sustained funding to committed recovery teams may be an improved model over the current annual cycle of species-based funding model of the Habitat Stewardship Program.

Box 5.8: Responses on the need to strengthen the recovery team model

'Recovery Team model rather than contracted consultants who are financially dependent on government for additional contracts to write strategies. Interdisciplinary research and writing teams that include not only field biologists but also conservation practitioners, impact assessment researchers, mathematical ecologists, social scientists, applied ethicists and so on.' (response to Question 10).

'I am concerned that recovery strategies are now often done by consultants and not a team of experts.' (response to Question 15).

'Multi-species or ecosystem-based recovery plans are being seen as a silver bullet, but (a) they are hard to do well; and (b) if they suffer from the same lack of commitment and resources as recovery planning classic, they won't be an improvement.' (response to Question 14)

Overall, one of the key benefits of increased collaboration would be to build a sense of shared responsibility and governance for species at risk in Canada (**Box 5.9**). While the leadership role of the federal government in species at risk has been important for SARA, the multi-jurisdictional coordination of activities through the Canadian Endangered Species Conservation Council has not been fully achieved. New approaches to collaboration including developing detailed provincial/territorial action plans/Nature Agreements, using KBAs as a focal point for species recovery, and renewing Recovery Teams that include co-production of knowledge with Indigenous communities could help to focus recovery on implementing priority actions and also reinstate species at risk recovery in Canada through the whole of government and whole of society approaches called for Canada's 2030 Biodiversity Strategy.

Box 5.9: Responses on the need to build ownership of recovery documents

'The move away from recovery teams, in which a group of experts/community members was involved in the development of a strategy, was very detrimental because it removed 'ownership' of the implementation of the strategy. It was not tenable to have recovery teams for every species, but now many recovery strategies are not really implemented.' (response to Question 14)

Recovery documents will be more effective if the jurisdictions that will be required to implement the actions view the documents as their plan. For terrestrial species the federal government has little jurisdiction and Indigenous Governments, Provincial and Territorial governments will be largely responsible for implementation. For aquatic species DFO has a large portion of the jurisdiction but that is shared with Indigenous and P/T [provincial/territorial]..... Revisiting and implementing the 1996 Accord to establish meaningful collaboration on SAR across jurisdictions would also help. (response to Question 11)

'From 2010 to 2014 NGOs and industry groups worked on this issue and found.... that the process does not help build a sense of ownership of the strategies or plans by those that would need to take action or be affected.....' (response to Question 10)

Opportunity 2: Streamline & combine documents

The survey highlighted a general sentiment that current approaches to recovery planning in Canada is highly bureaucratic with an over emphasis on planning over action (see **Opportunity 6**). Part of this stems from the many different planning documents that are prepared. Over 40% of respondents identified the integration of recovery strategies and management plans with action plans as a high priority and survey respondents identified potential approaches to streamline and combine recovery planning to improve efficiency.

The first approach to improving the planning process is to reduce the overlap between recovery documents and COSEWIC assessments. COSEWIC assessments include detailed information on biology, range, and threats that are essential to developing recovery strategies but do not need to be repeated in recovery documents unless there is significant new information. As identified by one respondent, COSEWIC assessments now include detailed threats assessments that can be more easily translated into recovery documents (**Box 5.10**). However, there will be cases where COSEWIC has averaged the threats across the species range, and more details are needed to develop local place-based recovery actions.

Box 5.10: Responses on streamlining recovery documents

The newer, more thorough COSEWIC assessment reports (that include threat assessments and IUCN-CMP descriptions of threats) are VERY helpful to us, as they allow us to prepare more streamlined rec docs [recovery documents] that refer to the COSEWIC report. This frees up capacity for us to get through the seemingly infinite backlog of rec docs [recovery documents] to produce. (response to Question 15)

The recovery process could also be streamlined by COSEWIC assessments including a brief statement on priority recovery actions. In addition to 'kick-starting' recovery planning, this would support the direction of funding programs. The Habitat Stewardship Program makes up to 20% of its annual budget available for species that have been designated by COSEWIC as endangered, threatened, or special concern but are not listed on Schedule 1 of SARA. This important proactive conservation can help to mitigate threats or protect habitat before a recovery document is completed, and practitioners and funding agencies would benefit from COSEWIC's advice on what those most urgent recovery actions should be. This would also formalize the expert collaboration that already exists between species

assessments and recovery planning (**Opportunity 1**). COSEWIC's early advice on priority actions in the assessment document would support proactive approaches to recovery action.

While survey respondents called for less detail in recovery documents where this overlaps information in COSEWIC assessments, adding more action-oriented details and integration of recovery strategies and management plans with action plans is another suggested approach to improving recovery documents. There has already been a trend toward the concurrent development of recovery and action plans for some species (e.g. Eastern Waterflea [*Peltigera hydrothyrta*]) and many recovery strategies developed by DFO already have sufficient detail for implementation.

Other opportunities to reduce documentation include the coordination and adoption of provincial and federal recovery documents. While in some cases, a federal recovery document must integrate provincial/territorial plans and include elements required under SARA, such as critical habitat, many recovery documents include overlapping information from federal and provincial/territorial planning (see **Opportunity 5**).

Opportunity 3: SMART recovery targets

More specific and measurable targets were identified as a high priority by 51% of respondents and was a common theme in the free text answers. Many recovery documents currently have objectives that are vague and difficult to measure and report (**Box 5.11**). Current reporting on progress of species at risk towards their population and distribution objectives includes 144 species, there are also 83 species for which recovery or management objectives and reassessments exist, but insufficient evidence is available in the reassessment to assess trends (ECCC 2023c). These 83 species are a symptom of a lack of reporting and resources for reporting, but also that recovery document objectives can lack specificity which make reporting more difficult. Recovery documents in the US prepared under the *Endangered Species Act* tend to use more explicit language compared with often vague language used in SARA recovery documents (Pawluk et al. 2019). Specific actions and resources to fill key knowledge gap for species that lack quantitative data needed for reporting on recovery progress need to be identified (Drake et al. 2021).

Comprehensive species inventories and assessments will support the development of SMART (Specific, Measurable, Achievable, Relevant, and Time-bound) recovery documents that are focused on recovery, and not more inventories. Currently, many species listed on SARA lack documentation of their range and population size. While this should be expected for some species, and especially cryptic species, it results in two major issues. The first is that species are listed, and recovery plans developed, only to have subsequent surveys determine the species is in a lower risk category or not at risk (**Chapter 2**). The second is that SMART recovery actions cannot be developed, and recovery documents often focus on research and monitoring rather than actions that will reduce extinction risk. Even within action plans, 46% of management tasks in action plans are research and monitoring (Buxton et al. 2022).

Box 5.11: Responses on making recovery documents more actionable

'Include detailed recovery actions that consider species needs AND feasibility of implementation and provide guidance to implementers on HOW to implement them (e.g., detailed steps for implementation)' (response to Question 10)

'I think the biggest barrier to effective recovery planning is that it tends to very high level and goal/objective-focused and often doesn't provide detailed direction on HOW to implement key actions. For example, including road mortality mitigation as a high priority recovery action for a reptile or amphibian species is important, but it is not very useful without a plan for how to implement this at such a massive scale across the species range, which types of sites/situations to prioritize, and how to implement this effectively despite the considerable logistical and financial barriers. Not that I have the solutions, but I think there just needs to be more thinking about the "HOW" (and being realistic about it given limited resources) during the planning process.' (response to Question 14)

SMART recovery documents will also improve measuring of recovery progress (**Box 5.12**). Measuring recovery progress is a key challenge for SARA. Complete range and population information is missing for most species, and while some actions can be accomplished on a short time frame (e.g., habitat protection), actions related to threat abatement will take generations (e.g., climate change, improvements in water quality) (see **Chapter 2**). However, measuring progress is a critical link in the species at risk conservation cycle because it informs future assessments and recovery actions. While not every indicator of recovery progress can be directly measured, few population and distribution objectives in recovery strategies are measurable. Evidence is critical to adapting conservation strategies (Salafsky et al. 2022). Including SMART recovery targets or linking objectives to COSEWIC's assessment criteria could help to better determine recovery progress and efficacy of recovery actions in achieving objectives.

Box 5.12: Responses on measuring species recovery

'Any measure that is a reliable indicator of genuine improvement is defensible. In many cases, provincial recovery goals are so vague that the concept of consistency applies only loosely.' (Question 13)

Better development of clear and numerical recovery targets that are based on best available information (not perfect) but reflect actual recovery rather than population maintenance. (Question 13)

Opportunity 4: Threat-based and ecosystem-based recovery planning

Focusing recovery planning on addressing threats emerged as a key theme from the survey results, both in terms of prioritization and improving the effectiveness of recovery plans (**Box 5.13**). While SARA has made significant progress assessing and classifying threats using a 'threats calculator' that is based on the international taxonomy of threats (Salafsky et al. 2008), recovery planning could be improved by differentiating between the scope, scale, and irreversibility of threats facing each species. More detailed consideration of threats in context of existing conservation measures, including protected and conserved areas, could also support the prioritization of species for recovery planning (see **Challenge 2, Box 5.13**).

Species that are only assessed as at risk under Criteria A (population decline) are often widespread and can still be common but facing pervasive threats. Some of these species will require place-based action plans (e.g., protecting stopover sites for migratory species). However, many of the factors driving extinction risk of widespread species demand comprehensive, large-scale risk reduction strategies. Articulating pervasive, larger-scale threats (e.g., climate change, non-point source pollution) and identifying current or needed strategies is essential for species at risk recovery. While these threats

should be included in recovery documents, there is a need to recognize that many mitigation actions essential for wildlife survival and recovery must be consolidated into broader strategies and not re-invented in every recovery document.

Box 5.13 Responses on threat-based recovery planning

‘More and more species are being added and information becomes quickly out of date, by also addressing the main threats or having recovery documents targeted to ecosystems or ecological communities and their main threats would benefit the recovery of species and their habitats.’ (response to Question 14)

‘Recovery planning should be done more spatially explicit either at the local population scale or by important threats (i.e. assessing threats spatially) - whatever makes sense’. (response to Question 14)

‘A real shift is needed from symptom (species declines) to cause (threats).’ (response to Question 15)

Recovery strategies and approaches to protecting critical habitat should be aligned with the specific risk criteria. In Canada, species are categorized into risk levels using quantitative criteria developed by the IUCN and adapted by COSEWIC. Species with small ranges (Criteria B), small and declining populations (Criteria C), or very small and restricted populations (Criteria D) generally inhabit limited areas or specific ecosystems, making them especially vulnerable to extinction or extirpation due to both human and natural events. These species are typically at risk from localized threats that can be clearly identified and mitigated at the ecosystem level, making the identification and protection of critical habitat most crucial to their survival and recovery (**Box 5.14**).

Species with small ranges and populations also stand to benefit the most from ecosystem-based recovery approaches. While not new to SARA implementation, ecosystem-based approaches have a strong foundation. The 2002-2003 RENEW annual report identified 10 ecosystem-based and 14 multi-species recovery documents covering 117 species—representing 44% of all species assessed as endangered or threatened by COSEWIC at that time (RENEW 2004). Place-based and ecosystem-based approaches can also be used to identify species that may serve as a ‘recovery umbrella’ for other rare and range restricted species, regardless of their listing under SARA.

Box 5.14 Responses on critical habitat

‘...be selective in use of critical habitat as a priority. Habitat availability is not always a strong limiting factor for species in question.’ (response to Question 14)

‘Recovery planning should be done more spatially explicitly either at the local population scale or by important threats (i.e. assessing threats spatially) - whatever makes sense’. (response to Question 14)

‘A real shift is needed from symptom (species declines) to cause (threats).’ (response to Question 15)

‘Less energy on critical habitat where a species doesn’t really need it, more energy on addressing the most impactful threats.’ (response to Question 14)

‘More detailed planning at the local population scale. Recovery Strategies tend [to] assess threats and develop recovery strategies that are generalized to the entire population. There is an opportunity to do more detailed planning in action plans but I have not seen that yet in federal documents.’ (response to Question 10)

Opportunity 5: Adaptive and regular recovery reporting

Since SARA was enacted just over two decades ago, there has been significant focus and progress on species assessments and recovery planning. These final two opportunities focus on the recovery challenges of reporting and action.

While our survey results point to an implementation gap, or a ‘knowing-doing gap’ (Hulme 2014), there is also a ‘doing-knowing gap’ in species at risk recovery in Canada. The SARA Registry does not include several recovery strategies that have been complete provincial and territorial agencies. These include species restricted to one province such as Hare-footed Locoweed (*Oxytropis lagopus* var. *conjugans*) in Alberta and Golden-eye Lichen (*Teloschistes chrysophthalmus*) (Great Lakes population) in Ontario. Also, as identified in the recent Auditor General report (Office of the Auditor General of Canada 2022), there remains a major backlog of implementation reporting, and there are many recovery actions that are not reported (**Box 5.15**). The SARA species at risk conservation cycle (**Figure 13**) does not always happen sequentially, and many conservation recovery actions occur before recovery planning and documentation, and many species listed under SARA have improved in conservation status without a recovery document as practitioners act before plans are produced and published (see **Chapter 2**). There are many examples of recovery actions that occur before recovery documents are published. These include actions by provinces and territories (e.g., Redside Dace [*Clinostomus elongatus*] in Ontario), federal government agencies (e.g., Whitebark Pine [*Pinus albicaulis*] by Parks Canada), civil societies (e.g., Limber Pine [*Pinus flexilis*] by Whitebark Pine Ecosystem Foundation of Canada), and Indigenous communities (e.g., Polar Bear [*Ursus maritimus*] in Nunavut).

Reinvigorating reporting by the Recovery of Nationally Endangered Wildlife (RENEW) program presents an opportunity to enhance collaboration across conservation efforts. Launched in 1988 as Canada’s national recovery program for species at risk, RENEW was endorsed by the Wildlife Ministers Council of Canada to report publicly on progress under the Accord for the Protection of Species at Risk. From 1989 to 2006, RENEW published annual reports, produced by the Canadian Wildlife Service of Environment Canada in collaboration with provinces, territories, Fisheries and Oceans Canada, Parks Canada Agency, Wildlife Management Boards, and non-governmental conservation groups. Unlike the implementation reporting required under SARA, RENEW reports provided a comprehensive overview of annual recovery actions and highlighted best practices. Reviving these annual reports, including the consolidation, analysis, and summary of implementation reports, would offer a valuable platform to showcase current collaboration and strengthen connections among recovery practitioners.

Box 5.15: Response on recovery reporting

‘As jurisdictional governments, our work isn’t done when we publish a new recovery doc; it’s done when the species shows improvement. Executive likes to post metrics like #documents completed, but don’t put any resources/capacity into even monitoring/reporting efforts to ensure the actions are being done ... by anyone.’ (response to Question 14)

Opportunity 6: Action to implement

The perceived lack of action to implement recovery documents is one of the key outcomes of our survey (**Question 9**). This perception is supported by data on recovery progress (ECCC 2023a; 2023b). Drivers of this inaction identified by respondents include funding approaches, lack of funds, and political will. By streamlining and finding efficiencies in the planning process (**Opportunity 2**), more funding would be available for more accurate species assessments, recovery actions, and filling key information gaps, including the identification of critical habitat (see **Box 5.16**).

In addition to enhanced collaborations (**Opportunity 1**), acting on recovery documents could also be improved through better linkages between recovery actions and funding priorities. One of the primary federal sources of funding for recovery actions is the Habitat Stewardship Program (HSP). HSP was established in 2000 and provides funding for projects proposals that contribute directly to the recovery objectives and population goals of species at risk listed on Schedule 1 of the SARA or designated at risk by COSEWIC. The Canadian Wildlife Service manages grants for terrestrial species and DFO manages grants for aquatic species. During each annual funding cycle, CWS publishes priority species and actions by Canadian Wildlife Service region. There is currently significant variation between regions in these priorities. In the most recent call for HSP applications, Atlantic region (CWS) lists only species, while Pacific (CWS) lists five high level threat mitigation actions. DFO regional priorities are grouped by species, areas, and threats, while CWS priorities are not. In addition to having standard approaches to setting priorities, CWS and DFO could prioritize specific recovery actions and outcomes that will be funded. As discussed in **Opportunity 1**, this could include adapting HSP to focus on multi-year funding, sustained funding to recovery teams and other place-based organizations. Developing a clear ‘recovery allocation framework’ may also support consistency in regional HSP priorities (Hayashi 2022).

Finally, enhanced reporting (**Opportunity 2**) provides an acritical venue to share recovery progress, challenges, and best practices. Despite the increased risk of many species, there are many examples of recovery through a wide variety of both traditional and innovative actions (**Chapter 2**). Sharing this progress with practitioners and the public can provide evidence of success and motivation for accelerated action.

Box 5.16: Responses on funding allocations

‘Cdn RS [Canadian recovery strategies] have become policy driven rather than science driven. The nature of SAR [species at risk] protection means that it is a costly process to develop, review, post, approve and publish a recovery strategy. The lion's share of government funding is absorbed in the recovery planning process rather than in implementation, to the detriment of SAR. It should be the reverse.’ (response to Question 14)

(on ways to improve recovery planning) ‘...ECCC invests money upfront for proper assessments of rare/data limited species thus avoiding the listing of many species and the huge amount of time and resources required to develop RD [recovery documents]’ (response to Question 15)

5.5 CONCLUSION

Our paper presents the results of the first comprehensive survey of recovery planning practitioners and experts in Canada. Overall, our results highlight a general sentiment that while preparing recovery documents is useful, the process has opportunities for improvement and there is too much focus on recovery planning as the goal, rather than using the planning process to enable effective on the ground implementation that results in improvements in the conservation status of species at risk.

Several respondents provided feedback on the structure and limitations of the survey. Species recovery is diverse and complex, and respondents were required to average responses or respond based on the situations they most frequently encounter. While most respondents provided free text responses, follow-up interviews with recovery planning practitioners from a diversity of backgrounds and institutions would provide additional details. A question asking respondents to identify examples of effective recovery documents would have been useful to analyze the best practices and conditions for success.

The purpose of SARA is to act, not to plan. Species at risk can recover without a plan, but not without action (see **Chapter 2**) and the results of our survey call for greater focus on results over process. While the lack of recovery progress is in part caused by the bureaucracy of planning, it could also be interpreted as a necessary stage in the development of SARA as the process to develop national recovery documents is tested and adapted. We hope the results of our survey can be used with other recommendations to improve species at risk conservation in Canada (e.g., Smart Prosperity Institute 2018), including the former Species at Risk Advisory Committee, and support the transition from a focus on planning to the protection and monitoring reporting components of the SARA species at risk cycle and close the loop to a more adaptive and effective process to recovery endangered wildlife in Canada.

CHAPTER 6. SYNTHESIS: TOWARDS RELATIONSHIP-BASED WILDLIFE RECOVERY

6.1 SUMMARY

Reversing wildlife extinction is a complex social-ecological problem. The status trends, and health of almost all wild species are determined by societal values, economic drivers, political decisions and ultimately our relationship and perceptions of the natural world. As outlined in Chapter 1, despite wavering at the edge of the ‘sixth extinction’, there is evidence for optimism. Over the last 150 years, Canada and most nation states have institutionalized wildlife conservation and taken actions that range from establishing protected areas to enacting new laws to protect nature. These responses have been driven by social norms and a culture that increasingly cares about the intrinsic value of wildlife and recognizes the benefits that nature provides to our economy and well-being. The transformation of our biodiversity conservation attitudes and actions has recently culminated in the Kunming-Montreal Global Biodiversity Framework (KMGBF) and Canada’s 2030 Nature Strategy that, among four goals and 23 targets, includes the vision to halt and reverse the loss of nature, stop extinction, and to recover threatened species.

The impetus for this thesis was a recognition that despite bright spots of recovery, and what appears as a multitude of enabling factors in support of wildlife recovery in Canada, the diversity of abundance wildlife continues to decline. Most importantly, it sought to identify tangible outcomes to support the recovery of endangered species by addressing my three research objectives:

1. Identify the patterns and processes of wildlife extinction and recovery in Canada, with a detailed examination of nationally endemic species (Chapters 2 & 3).
2. Compare and examine the effectiveness of national endangered species assessment, listing and recovery, thereby identifying bridges and barriers to recovery (Chapter 4).
3. Develop and advance new approaches and paradigms to accelerate endangered species recovery in Canada (Chapter 5).

Chapter 1 is focused on providing a summary of species at risk conservation in Canada framing the issue of wildlife extinction but also offers important implications for practice, particularly in response to the call of the KMGBF for transformative actions. This chapter identifies how societal values around wildlife conservation have shifted over the last century in terms of both attitudes towards wildlife and the species we chose to save and how Canada’s domestic implementation of the KMGBF provides a renewed opportunity for biodiversity conservation.

Chapter 2 provided the first comprehensive accounting of extinction and species at risk recovery in Canada and examined the attributes of species that have improved in conservation status. It documents over 200 species that have been lost from Canada and the locations and drivers of their disappearance. Wildlife recovery is examined in both a contemporary and historical perspective to document the drivers of success. The analysis is also the first assessment of genuine and non-genuine species recoveries in Canada and found that most improvements in the conservation status of species at risk are the result of new information.

Chapter 3 provides the first national list of endemic species in Canada. Most of these are range-restricted and 90% are also of global conservation concern. The analysis also identified 27 concentrations of endemic species, many of which are associated with glacial refugia, islands, coasts, and unique habitats, and highlighted that most endemic species at the greatest risk of extinction are not protected under SARA.

Chapter 4 explored pathways to endangered species recovery by analyzing the barriers that have been identified in Canada, the US and Australia and highlighting ten “bridges” that could help overcome these barriers. These bridges include ecosystem approaches to recovery, building capacity for community co-governance, linking wildlife recovery to ecosystem services, and improving our storytelling about the loss and recovery of wildlife.

Finally, **Chapter 5** provided the first survey of recovery plan practitioners in Canada. While these experts have a high degree of confidence in the effectiveness of recovery documents, very few expect that recovery documents will be fully implemented. Practitioners prioritized nationally endemic and species of global conservation concern and highlighted that species with existing place-based or legal protection should be a lower priority for SARA. Opportunities for improvements in recovery documents included streamlining processes, sharing best practices, and more effective consultations.

In addition to providing novel contributions to knowledge that support a better understanding of wildlife extinction and recovery in Canada, there are several implications for practice and opportunities to transform approaches species at risk conservation. This final chapter extends my final research objective, consolidates chapter recommendations, and explores opportunities for new approaches and paradigms for the practice of endangered species conservation in Canada.

6.2 IMPLICATIONS FOR PRACTICE: TOWARDS RELATIONSHIP-BASED WILDLIFE RECOVERY

In conclusion of this thesis, the driving question behind its inception and inspiration needs synthesizes: what can we do to transform and accelerate the recovery of wildlife in Canada? Some potential answers are explored in the chapters. The attributes of species that have been lost and recovered (**Chapter 2**) highlight the importance of stopping unsustainable harvest, the role of habitat loss in contemporary species losses, and that recovery actions for species with small ranges can reduce the risk of extinction within a relatively short period of time. Canada’s nationally endemic species, the species that we have full jurisdictional responsibility for, are poorly protected, but many occur in hotspots where ecosystem-based approaches could conserve multiple species (**Chapter 3**). Canada’s responses and results of endangered species legislation has many similarities to the US and Australia (**Chapter 4**), with common barriers and bridges including the opportunity to better differentiate recovery actions between threat-based and place-based extinction risk, the need for more ambitious recovery objectives, and the role of communications. A survey of recovery document practitioners (**Chapter 5**) echoed many of these conclusions, and emphasized the importance of Indigenous knowledge systems, streamlining the planning process, and better integration across programs and the species at risk conservation cycle.

Canada has a long history of wildlife recovery that extends from early efforts to prevent the extinction of game animals in the late 1800s to Canada’s *Species at Risk Act* (2002) and the recent 2030 Nature Strategy. While politics, culture, and scientific approaches to wildlife recovery have transformed over

time, a general pattern of results has remained constant: while there has been extraordinary success for some species, the richness and abundance of wildlife has continued to decline.

Our approaches to endangered species conservation have always been in transition. Recovery efforts were originally focused on game animals, and then on rare charismatic species. Today, species conservation encompasses all species and infraspecies, and includes species that remain common, but are in rapid decline. This expanded scope of conservation combined increasing threats has resulted in a large and ever-expanding number with species listed under SARA, and an even larger and expanding list of candidate species. As the challenge of endangered species recovery grows in scale and complexity, we need to both build upon current effective strategies and envision novel approaches to solve the extinction crisis.

Historical and contemporary wildlife recovery is largely based on single species approaches. In many cases, species-focused approaches have proven very effective. Species based approaches will continue to be essential for the recovery of many species that require specific actions to mitigate threats and for species that will not recover without captive breeding and translocation. However, while past wildlife conservation in Canada was focused on a few dozen well-documented species with small ranges or small populations, conservation today and in the future must halt and reverse the decline of thousands of wildlife species. This includes species that lack basic information on their biology, range, and threats, and species that remain common but have an *observed, estimated, inferred, projected, or suspected population reduction*¹. This recovery must occur in context of a planet where the threats to wildlife have increased in diversity, scope, and magnitude, often with complex, synergistic, and uncertain interactions. This emerging world of conservation creates challenges for not just biodiversity, but for conservation practices and practitioners that must quickly respond to the volume of species in need of action set within the stage of a dynamic and uncertain world. Moving new species through the SARA species at risk conservation cycle of assessment, protection (listing), recovery planning, implementation, and monitoring/evaluation while also reassessing and managing species currently listed under SARA is already straining human and financial resources (**Chapter 5**), delaying recovery actions (**Chapter 4**), and leaving species behind, including Canada's endemic species (**Chapter 3**), resulting in a growing list of species that have now become extinct or extirpated (**Chapter 2**).

While SARA has provided a legislative framework for the recovery of species at risk, legislation comes with institutional rigidity that can delay action and create metrics that focus on templated 'deliverology' over genuine outcomes. Current approaches have often contributed to reductionist approaches that focus on the silos of the SARA species at risk conservation cycle and jurisdictional responsibility rather than achieving the purpose of the Act. These conservation challenges are not unique to endangered species. Canada's 2030 Nature Strategy highlights the need for transformative 'whole of society' and 'whole of government' approaches that move conservation to a more holistic and integrated ways of knowing and doing.

The timeline of wildlife recovery (**Chapter 1**), more contemporary successes (**Chapter 2**), and different national approaches (**Chapter 4**) showcase the diversity of pathways to successful wildlife recovery. **Chapter 3** provides an example of how creating stories around a group of species (nationally endemic) can lead to public interest and engagement. **Chapter 5** summarizes key opportunities recovery practitioners identified to accelerate success, including more integration of Canada's species at risk conservation cycle. A common and critical theme throughout these chapters is that connecting the

¹ See IUCN criteria A4.

processes, places, and peoples of species at risk conservation through relationship-based wildlife recovery is needed to advance the recovery of Canada's wildlife. The conclusion of this thesis reflects upon relationship-based wildlife recovery, approaches that challenge existing paradigms to halt and reverse the loss of biodiversity, and opportunities for future research. While this thesis focused on applied strategies, it recognizes that the transformation of endangered species conservation has often occurred through incremental steps. The ideas and approaches presented in this final chapter are intended to be achievable within our current systems and structures but also provide a new paradigm for species at risk conservation.

6.2.1 PROCESSES

There have been many reviews and recommendations for potential improvements in SARA processes (e.g., Gordon et al. 2024; Turcotte et al. 2021) including reducing delays in protection and recovery, harmonization of legislation, and increased enforcement (**Chapter 4**). One of the key drivers of these issues are the dispersed jurisdictional responsibilities and reductionist approaches inherent in the species at risk conservation cycle. This compartmentalization of conservation can result in a focus on components rather than the purpose of SARA and the Accord for the Protection of Species at Risk (1996). While current processes are supporting recovery of some species, this has not been sufficient to halt and reverse the loss of species in Canada (**Chapter 2**). Acknowledging the interrelationships between SARA responsibilities and processes and building connections within the SARA species at risk conservation cycle would support more efficient and effective species at risk recovery in Canada. Key opportunities to build on these process relationships are through preemptive conservation, integrating recovery documents with a focus on action and outcomes, and linking funding to recovery priorities. Exploring these could help to reduce redundancy, reallocate funds to recovery, and perhaps most importantly accelerate recovery actions to achieve the purpose of SARA.

COSEWIC assessments raise the first red flag of extinction risk under SARA and are an opportunity to 'kick-start' preemptive recovery actions. Assessments contain a wealth of information of the biological and anthropogenic factors that increase vulnerability to extinction and, for endangered and threatened species, use quantitative criteria to assess risk. COSEWIC is an independent scientific body focused on assessment, but almost 60% of the members also participate in recovery planning (**Chapter 5**). While assessments cannot provide detailed recovery actions, they could suggest 'no-regret' actions that would reduce extinction risk based on the criteria and threats (**Table 26**). For example, in Australia assessment documentation includes a section on 'current and recommended management and research actions' and species status assessments by New York Department of Environmental Conservation include a section to 'describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats'. COSEWIC's preemptive recommendations would help to accelerate recovery actions by local conservation practitioners and direct the portion of Habitat Stewardship Funding that is allocated toward species assessed by COSEWIC but not yet listed under SARA.

Preemptive conservation can also occur before species are assessed. In addition to COSEWIC candidate lists, species assessed as imperiled by NatureServe and general status report could be more widely publicized to encourage both research and conservation action by practitioners. Resulting research and inventories may increase our knowledge of species before assessments and reduce later 'recovery by discovery' (**Chapter 2**), while preemptive actions may result in a reduced level of risk when species are assessed. Funding preemptive conservation, potentially through another stream of Habitat Stewardship Fund, would be an investment that could prevent species from being unnecessarily listed in the future.

One of the key themes from our survey of recovery plan practitioners was the need to streamline recovery documents to avoid duplication with species assessments and move more quickly towards action. This includes combining recovery documents with action plans. While recovery planning and action planning were originally conceived as different processes so that action plans could incorporate socio-economic factors, there has already been a trend in merging these documents. Much of the information included in section 2 of action plans (evaluation of socio-economic costs and benefits) could not only be included in recovery strategies but is helpful to inform recovery objectives (e.g., policy baseline, costs and benefits help to inform key recovery actors). In addition to potentially reducing time and costs, combined recovery/action plans can avoid unnecessary multiple consultations with interest groups, stakeholders, and rightsholders. As discussed in the next section (6.2.2), recovery/actions plans can also be integrated into place-based planning.

As explored in **Chapter 2**, most species at risk with genuine recovery did not have completed recovery documents, but they had targeted actions that effectively reduced threats and/or increased the range and population of the species. Reducing the period between assessment and recovery planning can facilitate advancing COSEWIC information on species' biology and threats into recovery planning, without needing to repeat research and consultations. In many cases the assessment information can be simply referenced, so the recovery document can focus on action. One of the key steps is to continue the trend of combining recovery documents and action plans and ensuring the recovery objectives are clear and measurable. This would help to direct on-the-ground practitioners and better reporting of progress towards population and distribution objectives (ECCC 2023c). As discussed in **Chapter 4**, some recovery documents are beginning to include the links to assessment criteria. More clearly defining and quantifying how population and distribution objectives and actions could impact criteria during reassessment can provide a clearer roadmap to recovery.

Recovery could also be accelerated through improved coordination of COSEWIC re-assessments with recovery planning documents. This would reduce the number of instances where there is a temporal mismatch between the species status and recovery planning, particularly when a species may be downlisted to special concern. As identified in **Chapter 2**, there are seven cases where recovery documents were published concurrently or after a status change. While species reassessments and recovery planning are separate in the SARA species at risk conservation cycle, they serve the same purpose of reducing extinction risk.

SARA prioritizes species through assessments and recovery planning, but perhaps the greatest influence on recovery are the priorities set through funding. As discussed in **Chapter 5**, there is significant variation between CWS and DFO regions and how priority species are selected for funding through the Habitat Stewardship Program and Canada Nature Fund for Aquatic Species at Risk. In addition, programs to fund private land securement (e.g., Natural Heritage Conservation Plan - Land Trusts Conservation Fund) include habitat for species at risk in their guidelines, but don't prioritize endangered species over species of special concern. Canada's 'priority species' under the Pan-Canadian approach to transforming species at risk conservation in Canada, are primarily focused on caribou, which for most populations the greatest risk is continued or projected decline compared to hundreds of other species that are at greater imminent risk of extinction or extirpation. Over two-thirds of our survey respondents identified that improved linkages between funding and action is a high priority to support implementation (**Chapter 5**). Understanding the current alignment between extinction risk, priority action, and calls for funding (**Table 26**) could be an important catalyst to accelerate species at risk recovery.

Table 26: ‘Processes’ research questions for species at risk recovery

- Could COSEWIC provide guidance on what changes would be needed to improve the status of the species based on the assessment criteria and suggest preliminary ‘no-regret’ recovery actions in assessments? Could this be done under the existing mandate to support SARA implementation?
- How could preemptive conservation of candidate species at risk and other species of conservation concern be better funded and implemented? Could this approach prevent species from being listed under SARA?
- What would be the approach in recovery documents to better link assessment criteria with population and distribution objectives and recovery actions?
- What are examples of recovery plans and action plans that have been combined? What are the principles for combining or keeping these separate? Did combining documents reduce time and expenses or result in better conservation outcomes?
- Have past funding federal and provincial programs and allocations been aligned with the species at greatest extinction risk and priority recovery actions?

6.2.2 PLACES

Current species at risk legislation and approaches remain largely based on the North American model of wildlife conservation (Organ et al. 2012). While this species-by-species approach has been very effective for many game animals that had declined (**Chapter 2**), the model begins to crack under the strain of halting and reversing the loss of thousands of species from multiple taxa. With one in five species (not including infraspecies) at some level of risk (CESCC 2022), species-based assessment, listing, and recovery planning creates a recovery bottleneck and our current systems cannot effectively cope with the growing number of species at risk. ‘Course-filter’ and place-based approaches to conservation have long recognized that targeted place-based actions can benefit multiple species (Findlay & McKee 2016; Hunter 1991). In addition, place-based planning and actions offer an opportunity for preemptive conservation that can reduce risk, and potentially negate the need to list species under SARA.

Place-based approaches to recovery were introduced shortly after SARA with the establishment of ecosystem recovery teams. While many of these collaborations were abandoned (e.g., Carolinian Woodlands, Bruce-Manitoulin Alvars), place-based approaches have again been recognized through priority places (ECCC 2018b). However, many priority places for multiple species at risk and other species of conservation concern remain poorly identified, without strategic planning and action and continue to separate aquatic and terrestrial species at risk. Current initiatives could be enhanced through overlays of ‘hotspots’ of nationally endemic species (**Chapter 3**), more detailed and comprehensive critical habitat mapping, and the identification of Key Biodiversity Areas (IUCN 2016). Many species at risk occur in ecosystems at risk. While threatened ecosystems are not included in SARA, improved identification and mapping of these places, including completing the Canadian National Vegetation Classification System and identifying Canadian ecosystems at risk (Nicholson et al. 2024), would support place-based conservation actions. While general regions with multiple species at risk are known (Coristine et al. 2019; Kraus & Hebb 2020), enhanced mapping and identifying the 100 top places for species at risk conservation in Canada that would provide the greatest return on investment could accelerate recovery.

While the current structure of COSEWIC subcommittees are based on taxonomic groups, this could be replaced or supplemented with a place-based committee to identify priority places and ecosystems, and

the species or species assemblages that could serve as an assessment and recovery umbrella to initiate and sustain place-based actions (Belitz et al. 2025). Encouragingly, over half of recovery plan practitioners reported expertise with more than one taxonomic group, and this expertise can be better harnessed to advance place-based approaches for many species at risk. While place-based recovery has a limited impact on species that are wide ranging or are declining because of threats that are not habitat based (e.g., Black Ash [*Fraxinus nigra*]), over 80% of species at risk are assessed under COSEWIC criteria B (small range), C (small population and decline), or D (very small population)¹. Understanding the relationship of these species to specific places is essential for their recovery. Local place-based plans could also be an opportunity to modify funding programs to support sustained resources to places, and not projects. Creating and supporting local approaches and plans can reduce issues of ‘top-down’ planning being imposed on local communities and governance structures (Nebasifu & Atong 2019).

One of the key elements needed for place-based approaches to recovery is critical habitat. Identifying critical habitat has been challenging for SARA. Many species do not have critical habitat maps, and survey respondents identified that more funds are needed to evaluate required habitat attributes for species (**Chapter 5**). One opportunity to accelerate critical habitat mapping is to focus on the 80% of species at risk that have small ranges and populations. Critical habitat mapping for species that are wide-ranging, have dynamic ranges, or that are not threatened by habitat loss is less important to inform conservation actions. Limiting mapping to the range of common and declining species and focusing more on understanding and mitigating critical threats would directly address their drivers of extinction risk and identify recovery actions (**Table 27**).

There are also places where SARA is less essential for the recovery of wild species. This includes places and ecosystems that already have multiple species at risk identified and current recovery actions will benefit species that could potentially be listed. Species that already have habitat protections through existing protected and conserved areas were also identified as lower priority for SARA by recovery planning practitioners in our survey (**Chapter 5**). Creating and testing mechanisms to recognize the conservation importance of these species in context of existing and effective measures (e.g., a globally rare species in a national park) could help to focus SARA on the species most urgently in need of action.

¹ Working data assembled by author.

Table 27: ‘Places’ research questions for species at risk recovery

- What species are restricted to the private land base in southern Canada? How could place-based conservation efforts enhance their recovery and reduce extinction risk? (Eichenwald et al. 2020)
- Are there places in southern Canada where the conservation status of multiple species at risk are improving or stable? What factors are enabling this success?
- What are the barriers to place-based and ecosystem-based recovery planning? How can effective ecosystem/place-based recovery documents be prepared and implemented while meeting the requirements of SARA?
- Does current critical habitat mapping provide sufficient information to inform place-based recovery actions?
- Which species don’t benefit from traditional critical habitat mapping? What approaches could be used to meet the requirements of SARA while proving more focus on pervasive threats?
- Which species at risk and candidate species at risk primarily occur within protected and conserved areas? Can these species be effectively conserved without SARA protections?

6.2.3 PEOPLES

Biodiversity conservation is ultimately rooted in the relationship between people and the natural world. While conservation is often positioned as being ‘science-based’, it is in fact a value-based discipline founded in our connections and perceptions of biodiversity that uses science to help guide decision-making. Western approaches to conservation have been dynamic and often conflicting, but they are all driven by relationships. While past descriptions of human relationships with wildlife have focused on ‘economic status’ (e.g., Banfield 1974; Taverner 1928) the full diversity of the benefits that nature provides to people are now becoming better recognized and mainstreamed as western society’s values toward nature continue to shift (**Chapter 1**) (Dasgupta 2021; Millennium Ecosystem Assessment 2003).

The preamble of SARA recognizes that ‘all Canadians have a role to play in the conservation of wildlife in this country’ and that ‘community knowledge and interests.... should be considered in developing and implementing recovery measures’ providing an early call for the ‘all-of-society approach’ in Canada’s 2030 Biodiversity Strategy. This relationship-based lens has always been the foundation of Indigenous approaches to conservation, including cultural keystone species (Mattalia et al. 2024). Integrating perspectives and knowledge is critical for managing complex and uncertain human-natural systems (Moallemi et al. 2023) and creating effective networks of recovery actors is essential to advance wildlife recovery in Canada. Implementation of the *Species at Risk Act* could be strengthened by better acknowledging and fostering the many relationships that people have with species at risk and their habitat. Integration of social sciences into conservation can improve outcomes (Bennett et al. 2017) and is an important step advancing the calls for mainstreaming nature conservation. Two key opportunities to move SARA from a science-based approach to transdisciplinary approach that integrates the relationship people have with species at risk are: 1) strengthening the relationships between people and species at risk in assessment and recovery documents and, 2) building a community of practice around species at risk recovery.

SARA documents and implementation generally position people as having a threat-based relationship to species at risk. While farming, forestry, and urban development certainly can and do cause the decline

of species at risk, they are also the livelihoods of people that live and work in the same places as the species that need conservation action. In addition, many species at risk have people that are engaged in recovery actions, even before they are listed on SARA. Deeper engagement with community actors and integration of their perspectives could improve conservation outcomes and foster local ownership of species at risk and their recovery.

There are growing examples of how the relationship between people and wildlife is being incorporated into endangered species conservation. Assessments and recovery strategies in Canada now include information on the cultural significance of species. The role of Indigenous Peoples in wildlife stewardship in Canada, this has become more central to species at risk recovery through the Aboriginal (Indigenous) Traditional Knowledge (ATK) subcommittee of COSEWIC and the inclusion of ATK in recovery documents. In Australia, recovery plans include a section of ‘affected interests’ and ‘social and economic considerations’ upfront, that include lists of the actors that need to be involved in recovery¹. Unlike Canadian recovery documents, these Australian plans often include images of people that have a cultural or conservation connections to the species.

Recovery documents have generally excluded people and their relationship with the species at risk, perhaps to maintain focus on the science of recovery and avoid social, political, and economic considerations. While recovery science is important, it is only one component of recovery. Delaying the consideration and connections between wildlife and people only stalls recovery action and risks alienating people with top-down approaches (Pittman 2019). Focusing first on the relationships between the species at risk and people in assessment and recovery documents would better recognize that recovery will occur within a complex social-ecological system. Simply highlighting recovery actions and actors in species reassessments (see **6.2.1 Processes**) could begin to integrate human dimensions into species at risk conservation. Developing and reporting on socioeconomic indicators of species at risk (e.g., species at risk with active recovery teams, spending on recovery actions by species) would support current efforts and may serve as a leading indicator for the probability of reduced extinction risk and that population and distribution objectives will be achieved (**Table 28**).

Most people support the conservation of endangered species and other conservation actions (see **Chapter 1**). Enhancing effective engagement by existing practitioners and increasing participation by a broader suite of actors can be strengthened by removing barriers and building the community of practice. Recovery planning and implementation for species with small populations and ranges should be led by community-based recovery teams that have sustained and long-term federal support. These could include Indigenous-communities, land trusts, other non-governmental organizations, or municipalities. Federal and provincial/territorial agencies could focus on planning support, information sharing, and knowledge mobilization, including the review and national roll-up of progress to support SARA implementation reporting. This approach may require some flexibility in planning and document formats, but this would allow for recovery to be customized to local conditions and offers greater opportunity for experimentation and finding novel practices that could support other recovery teams. While action plans in SARA were originally modelled on state wildlife action plans that support the US *Endangered Species Act*, this is an opportunity to transform SARA implementation towards community-led planning and stewardship initiatives. As action plans, these community-led initiatives should have a

¹ Recent example: National Recovery Plan for the Spiny Rice-flower *Pimelea spinescens* subspecies *spinescens*. <https://www.dcceew.gov.au/sites/default/files/documents/national-recovery-spiny-rice-flower-2024.pdf>

focus on reducing extinction risk and have clear and measurable objectives. Federal recovery efforts can focus on planning for species at risk that occur across multiple jurisdictions with pervasive and widespread threats that require broader consultations.

In addition, the federal government can focus also efforts on knowledge sharing and mobilization. This would include annual reporting and knowledge mobilization to practitioners on community-led place-based recovery, and highlighting best practices, successes, and results of novel approaches. This could be done through a renewed RENEW (**Chapter 2**), media releases, and annual reporting, including key messages that are aimed at the public and decisionmakers. This reporting should also highlight human relationships with species at risk including the people that are committed to wildlife recovery, the role of species in defining place, and the ecosystems goods and services communities receive by conserving and restoring critical habitat (**Chapter 4, Table 28**).

There is also an opportunity to build relationships with the academic community. Research is not focused on the most threatened species (Murray et al. 2015), and there is a gap in understanding the effectiveness of conservation actions in Canada (Binley et al. 2025). Many recovery documents and species at risk have research questions that would benefit from academic partnerships, while providing students with ‘real-world’ conservation questions to address (Castañeda et al. 2021). This includes filling basic research gaps such as the range, population, and threats to species at risk that may be limiting recovery actions, particularly by risk adverse government agencies. Academic partnerships can also go beyond research on the biology and ecology of species at risk through interdisciplinary research that explores the drivers, threats, and solutions to the biodiversity crisis (D. R. Williams et al. 2020).

All genuine species recoveries in Canada have resulted from people that were empowered to act. Often these actions were in the absence of policy and planning (**Chapter 2**). While more resources are needed to recovery species at risk in Canada (**Chapter 5**), this can be complemented by building the capacity and connectedness of community-based recovery practitioners. Inspiring, supporting, and funding these keystone recovery actors is at the heart of reversing the decline of wildlife in Canada.

Table 28: ‘Peoples’ research questions for species at risk recovery

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| <ul style="list-style-type: none"> • What is the past, present and future role of social sciences in species at risk recovery? • How have the social aspects of extinction risk and recovery evolved in SARA implementation? Are there examples where greater social-ecological integration has resulted in better outcomes? • What are the best funding models to sustain local leadership, governance and action in recovery implementation? How could the Habitat Stewardship Program be designed to better support long-term recovery actions by key actors. • What is the value of ecosystem goods and services provided by critical habitat? How can this be better leveraged to support conservation and recovery efforts? • Where do recovery practitioners find information and best practices to develop plans and actions? • What are the socio-economic indicators of species at risk recovery? |
|---|

6.4 THE FUTURE OF SPECIES AT RISK CONSERVATION IN CANADA

The diversity and abundance of wildlife on Earth is at an existential crossroad. For the first time in the history of our planet, biological diversity is rapidly declining not because of geological or cosmological events, but because of the pervasive activities of one species. For the first time in human history, our impact on nature and the benefits we derive from nature is not just local or regional, but planetary. Ironically at this pinnacle of nature loss, our collective awareness of the limits of natural systems, the consequences of our actions, and the solutions for transformation have never been more acute. Despite the current magnitude and severity of threats to nature and our collective lack of progress, examples and opportunities to reverse the decline of biodiversity are all around us. But these actions need to be accelerated immediately by both building on traditional approaches to conservation and developing novel ‘whole-of-society’ solutions to address the economic and social factors that are driving the decline and degradation of biodiversity.

Wildlife extinction and recovery operates within a complex social-ecological system and is primarily the result of human values and decisions. The species we value, and conserve has broadened from game animals to almost all species. We now value wildlife and biodiversity for reasons beyond traditionalist values and our understanding of the linkages between nature and people is becoming mainstream. The history of nature laws demonstrates how public attitudes and values may be at the leading edge of future conservation directions. Three “eras” in wildlife management have been described from Canada: game management, wildlife management, and sustainable wildlife management (Donihee 2000). Perhaps the fourth era we are entering is an era of renewed biodiversity relationships. As we move from species-based recovery to ecosystem-based recovery, the ultimate goal should be socioecological recovery. Recovery planning and actions, ranging from ecosystems restoration to citizen science monitoring, are not just about improving the conservation status of threatened species, but redefining and rediscovering our relationship with nature.

We stand with one foot on a path that will lead to continued impoverishment of the natural world, and the other toward a path of ecological enlightenment. The decisions we make in the next decade, including our progress fulfilling the vision and mission of the Kunming-Montreal Global Biodiversity Framework, will define our era. Our chosen pathway will result in the continued depauperating and homogenization of nature or a transformational tipping point to a nature revolution where people become a force that conserves and restores Earth’s biological diversity. This choice will impact nature and people forever.

I hope the final message to this research is one of optimism that is based on evidence of hope. There has been significant progress in transforming government and culture to recognize and support the conservation and recovery of wild species. The challenge is that these advancements have not kept pace with the severity and magnitude of threats. Canada’s *Species at Risk Act* and 2030 Nature Strategy are both starting points to better address the biodiversity crises. While they both provide a foundation of policy and planning, their effectiveness will ultimately depend on inspiring and empowering people to take meaningful action.

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APPENDICES

APPENDIX 1: SUMMARY OF PROVINCIAL & TERRITORIAL LEGISLATIVE PROVISIONS TO PROTECT SPECIES AT RISK IN CANADA

Jurisdiction/ Legislation/ TYPE OF ACT	Summary & Key Sources
Alberta Wildlife Act (1997, 2000) Current version: February 2018 WILDLIFE	The Government of Alberta does not have stand-alone species at risk legislation. Instead, following the signing of the National Accord for Species at Risk, Alberta changed certain sections of the <i>Wildlife Act</i> – historically focused on game species – to add rules for the designation and protection of species at risk. Species are assessed by the Scientific Subcommittee of the Endangered Species Conservation Committee – an advisory body that makes recommendations to the Minister. There is, however, no statutory obligation on the Minister to respond to status recommendations. The <i>Act</i> does not contain prohibitions against the destruction of habitat, but it enables the Minister to make regulations respecting the protection of wildlife habitat and endangered species. The provisions are limited, as they only prohibit the “willful molestation, disturbance, or destruction of a house, nest or den”, and there is no protection of other habitat. The <i>Wildlife Act</i> does not require recovery plans for species assessed at risk of extinction. In 2009, the Alberta Division of Fish and Wildlife developed a “Strategy for the Management of Species at Risk”, and while this is still on the website, it was only meant to be valid until 2014. The closest thing to recovery planning in Alberta is through the preparation of “Conservation Management Plans”. Interestingly, some species in Alberta that have conservation management plans do not have a federal recovery strategy (e.g., Hare-footed Locoweed). (Ecojustice 2012; Environmental Law Centre 2019; Fluker & Stacey 2012)
British Columbia Wildlife Act (1996) Current version: April 2019 WILDLIFE	British Columbia does not have stand-alone species at risk legislation. The Canada-BC Agreement on Species at Risk 2005 created an administrative framework within which BC and Canada can exercise their respective powers for species at risk protection and recovery in BC. In 2017, the Government committed to the enactment of an endangered species law but walked this back two years later. Only two of 64 species that legally require critical habitat mapping were completed on time (Hobbs 2022) and delayed habitat protections have resulted in the decline of species including Spotted Owl (<i>Strix occidentalis</i>) and Mountain Caribou (<i>Rangifer tarandus caribou</i>). Although BC has more species at risk than any other jurisdiction, protections largely rely on policies enacted through several different laws (e.g., the <i>Wildlife Act</i> (1996), the <i>Forest & Range Practices Act</i> (2002), and the <i>Oil and Gas Activities Act</i> (2008). Under the <i>Wildlife Act</i>, any vertebrate species (other than fish) can be legally designated as endangered or threatened, although the listing triggers no legal protection. Habitats of endangered or threatened species can receive some special designations through these statutes, but the enforceable prohibitions that apply to resource extraction activities (e.g., forest harvest) are variable in strength and limited in the extent of application. This patchwork approach collectively provides partial protection to a small number of species at risk in the province. Currently, only four designated species at risk are legally listed under the <i>Wildlife Act</i> and entitled to its limited protections. (ECCC 2017; 2022b; Palm et al. 2020; Westwood et al. 2019; Wilderness Committee & Ecojustice 2021)

Jurisdiction/ Legislation/ TYPE OF ACT	Summary & Key Sources
Manitoba Endangered Species and Ecosystem Act (1990, 2015) Current version: June 2018 SPECIES AT RISK	The Manitoba <i>Endangered Species and Ecosystems Act</i> (ESEA) is the primary provincial legislative tool to identify and protect species at risk and their habitat. Species and ecosystems are identified by the Endangered Species, Ecosystems and Ecological Reserves Advisory Committee. There is no indication, however, that this committee is operational at present. The ESEA includes prohibitions against destroying, disturbing or interfering with the habitat of listed endangered or threatened species. There is no requirement of the government to follow through on the recommendations of the committee and the last time that at-risk species were added to the list of species under the ESEA was 2015. Similar to other provinces, there are discrepancies in federal and provincial listing of species. Many species listed under SARA are not included in the ESEA and some species listed under ESEA are at risk in Manitoba, but not in Canada (e.g., Hackberry [<i>Celtis occidentalis</i>]). The Manitoba ESEA is unique in Canada because it includes provisions for designating endangered or threatened ecosystems. There are, however, only two ecosystems currently designated under the Act: tallgrass prairie and alvar (both as endangered), and both lack a recovery strategy. While species protection can apply to private lands, only Crown Land that supports a designated ecosystem can be designated as an Ecosystem Preservation Zone (EPZ). However, no EPZs have been designated to date. (Ecojustice 2012; ECCC 2022b)
New Brunswick Species at Risk Act (2012) Current version: December 2019 SPECIES AT RISK	New Brunswick had one of the first dedicated species at risk provincial statutes (<i>Endangered Species Act</i>), which came into force in 1973. This was replaced by the <i>Species at Risk Act</i> in 2012 as the primary provincial legislative tool that can protect habitat for species at risk on non-federal lands. The Act provides the Government of New Brunswick with the power to protect the habitat of species at risk by regulation or by order but only at the discretion of the Minister. A Committee on the Status of Species at Risk advises the Minister on status assessments of species at risk. It is at the Minister's discretion whether to designate recovery habitat or survival habitat for species, including on private lands. However, no regulations have been made, or orders are issued in respect to the designation or protection of species at risk habitat under the Act. (East Coast Environmental Law Association 2020)
Newfoundland and Labrador Endangered Species Act (2001, 2004) Current version: December 2005 SPECIES AT RISK	The <i>Endangered Species Act</i> (ESA) is the primary provincial legislative tool that can protect habitat for species at risk in Newfoundland and Labrador. Species are assessed by the Species Status Advisory Committee. Recovery plans are required to identify critical habitat, but only "where appropriate". However, no orders have been issued for species at risk under the <i>Endangered Species Act</i>, and implementation has focused on landowner incentive programs. Marine fishes (except for anadromous species, such as Atlantic Salmon [<i>Salmo salar</i>]) are excluded from the Act. One unique aspect of Newfoundland and Labrador's endangered species legislation is the statement: 'the Province supports, as a guiding principle, that all species have the right to exist, therefore no species should become extinct or extirpated owing to human actions'. While the preamble to SARA includes the statement 'wildlife, in all its forms, has value in and of itself' this is not part of the legislation, and Newfoundland and Labrador's Act is perhaps the strongest claim of intrinsic value in any endangered species legislation in North America. (Olive 2014a)

Jurisdiction/ Legislation/ TYPE OF ACT	Summary & Key Sources
Northwest Territories Species at Risk Act (2009) Current version: October 2017 SPECIES AT RISK	The responsibility for the conservation of wildlife (including species at risk) in the Northwest Territories is shared by the federal, territorial and Tłı̨chǫ governments, and wildlife co-management boards. Species are assessed by the Species at Risk Committee, which makes recommendations on the listing of species and on conservation measures to the Conference of Management Authorities (the ‘Conference’). The Conference, established under the Northwest Territories <i>Species at Risk Act</i>, builds consensus among these Management Authorities on the conservation of species at risk and provides direction, coordination, and leadership with respect to the assessment, listing, conservation, and recovery of species at risk, while respecting the roles and responsibilities of Management Authorities under land claims agreements. Each species status report presents “scientific knowledge” and “traditional & community knowledge” separately but equally. To date, 12 species have been listed (including four caribou ecotypes). Conservation measures, including habitat protection, are developed by the Conference through consensus agreements. The Northwest Territories Species Conservation and Recovery Fund provides funding for projects that support the long-term conservation, recovery and protection of species that are at risk in the territory. (Government of the Northwest Territories 2022; Singer et al. 2023)
Nova Scotia Endangered Species Act (1998) Current version: August 2010 SPECIES AT RISK	Nova Scotia’s <i>Endangered Species Act</i> predates the federal Species at Risk Act. Species are assessed by the Nova Scotia Endangered Species Working Group. The province is required to identify areas to be considered for designation as “core habitat” in recovery plans. It includes prohibitions against the destruction of residence and core habitat, including dwellings that are anthropocentric structures. Through the discretion of the Minister, the Act also provides the mechanism to list prohibitions against the destruction of species at risk habitat on private lands. Implementation of both recovery plans and core habitat identification have proceeded very slowly. Among the six provincial recovery plans that have been completed, only three (all plants) clearly identify areas in Nova Scotia that can be considered for designation as core habitat. One unique aspect of Nova Scotia’s legislation is that landowners must be compensated for loss of use if their lands are declared critical habitat. (East Coast Environmental Law 2021)
Nunavut Wildlife Act (2005) Current version: September 2008 WILDLIFE	In Nunavut, the <i>Wildlife Act</i> includes the protection and recovery of species at risk. A memorandum of understanding between federal agencies and the Nunavut Wildlife Management Board for ‘harmonizing designations for species at risk under Nunavut land claims and species at risk legislation’ was signed in 2008. Although the <i>Wildlife Act</i> has provisions for listing species, community consultations, and protection of listed species, and enables the establishment of a Nunavut Species at Risk Committee (to make status assessments) and recovery processes, none of this has been implemented. To date, federal species listings and recovery plans have been the focus of species at risk activities in the territory. (Government of Nunavut 2018)

Jurisdiction/ Legislation/ TYPE OF ACT	Summary & Key Sources
Ontario Endangered Species Act (2007) Current version: October 2021 SPECIES AT RISK	Until recently, Ontario had one of the strongest endangered species acts in North America. Replacing the original <i>Endangered Species Act</i> of 1971, the new act that came into force in 2008 included automatic listing of species once they were assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO) and species-specific habitat protection orders. The first significant roll-back of Ontario's species at risk protection regime occurred in 2013, when a major set of 'conditional exemptions' were put in place. This allowed certain activities (e.g., forestry) conditional exemptions through a permit-by-rule system. This replaced individual permits that required government assessment and approval of harmful activities. This regulation was unsuccessfully challenged in court by a coalition of conservation groups. In evidence later compiled by the Auditor General of Ontario, the number of registered conditional exemptions skyrocketed as a result. Between 2019 and 2021, the Act was amended in three separate bills, including permitting the permanent exemption of forestry operations on Crown Lands from the ESA and its protection requirements for species and their habitats. Additional amendments included modifications to assessment criteria, timelines, and other changes to protection in the name of 'streamlining' approvals. In 2019, changes to the Act through the <i>More Homes, More Choice Act</i> (2019) required the assessment of species include their 'broader biologically relevant geographical range' (a term that remains to be fully defined by COSSARO) and an end to automatic listing. (Bethlenfalvy et al. 2021; David Suzuki Foundation et al. 2017; Office of the Auditor General of Ontario 2021)
Prince Edward Island Wildlife Conservation Act (1988) Current version: May 2022 WILDLIFE	The 1988 <i>Wildlife Conservation Act</i> provides the Minister with the power to protect species at risk. If a species were designated as endangered or threatened, it would receive automatic protection under the Act from being harmed or traded and automatic prohibition against destroying or disturbing its habitat. This is, however, entirely discretionary and no regulations have been made to designate a species at risk in the province. (East Coast Environmental Law Association 2022; Ecojustice 2012)
Quebec Act Respecting Threatened or Vulnerable species (1989) Current version: February 2022 SPECIES AT RISK	Quebec is the only province not to have signed the <i>Accord for the Protection of Species at Risk</i>. In 2006 the <i>Cooperation Agreement for the Protection and Recovery of Species at Risk in Quebec</i> was agreed to by the governments of Canada and Quebec. The province protects endangered species through dedicated species at risk legislation. Species are assessed by the Le Comité avisier sur les espèces fauniques menacées ou vulnérables du Québec. There is no legal requirement to produce recovery plans under the Quebec law. The statute also does not include an obligation to designate or protect habitat. An <i>Act Respecting the Conservation and Development of Wildlife</i> was introduced as a companion bill in 2009, which provides some provisions to support habitat conservation. (ECCC 2022b)

Jurisdiction/ Legislation/ TYPE OF ACT	Summary & Key Sources
Saskatchewan Wildlife Act (1998) Current version: July 2020 WILDLIFE	The Government of Saskatchewan does not have stand-alone species at risk legislation. The <i>Wildlife Act</i> (1998) is the primary provincial legislative tool that can address species at risk. Prohibitions are limited to the disturbance of the den, house, nest, dam, or usual place of habitation of vertebrate wild species at risk. The <i>Act</i> allows the government to designate an area of the province to protect wildlife and their habitat. However, it also includes provisions to authorize activities in these areas which are not subject to constraints consistent with those under the federal <i>Species at Risk Act</i>. The Wild Species at Risk Regulations came into effect in 1999. These provide protection for 15 species of plants, birds, and mammals – five of which are considered extirpated from Saskatchewan. This list has not been changed since that time. ‘Specially protected wildlife’ (just four species) are subject to prohibitions from hunting, trapping or possession. The province launched several unique initiatives to protect species at risk on private lands including the Saskatchewan Species at Risk Farm Program and HabiSask (an online mapping platform that unfortunately seems to lack data). (Olive 2018)
Yukon Yukon Wildlife Act (2002) Current version: April 2019 WILDLIFE	Yukon does not have stand-alone species at risk legislation. The <i>Wildlife Act</i> defines ‘wildlife’ as only vertebrate animals, excluding fish. The Committee on the Status of Endangered Wildlife in Canada, the Convention on International Trade in Endangered Species and the Wildlife Act are used to identify what species are at risk in Yukon. There is no independent assessment. The territory appears to automatically adopt COSEWIC assessments and SARA listings, but these are not included in the Act. Under the Act species are listed under only one category: ‘specially protected’. Four species currently have this recognition: Cougar (<i>Puma concolor</i>), Gyrfalcon (<i>Falco rusticolus</i>), Peregrine Falcon (<i>Falco peregrinus</i>), and Trumpeter Swan (<i>Cygnus buccinator</i>). (Canadian Parks and Wilderness Society 2019)

APPENDIX 2: SUPPLEMENTARY MATERIALS FOR CHAPTER 5

S1: Survey

Title: How can we help more of Canada's species at risk to recover?

A. First, here's some background

Q00. See information document

Q01. See consent

You are invited to participate in a research study conducted by Dan Kraus, under the supervision of Stephen Murphy, Faculty of the Environment of the University of Waterloo, Canada. The objectives of the research study are to identify opportunities to improve species risk recovery planning and accelerate effective implementation.

Purpose of the research and benefits of the study

The purpose of this research is to identify opportunities to improve species risk recovery planning and implementation. Experiences and ideas from experts like yourself will inform new approaches to accelerate recovery implementation of species at risk in Canada.

Context

Canada has almost 700 species listed under the Species at Risk Act (SARA). SARA requires that Recovery Strategies are prepared for species assessed as extirpated, endangered and threatened, and Management Plans are developed for species assessed as special concern. Action Plans are prepared to implement actions in Recovery Strategies.

Over 500 recovery documents* have been prepared. Several studies have identified issues related to the lack of recovery implementation such as delays in listing and the identification of critical habitat. Based on a survey of practitioners, this research will examine the process of developing recovery documents and focus on opportunities to improve their implementation to advance the recovery of species at risk in Canada.

*The survey uses the term recovery document. This includes a draft or final Recovery Strategy or Management Plan prepared under Canada's Species at Risk Act. These documents can be found on the Species at Risk Registry.

What we're asking you to do

If you have developed, implemented, or researched species at risk recovery documents in Canada, we're asking for your expertise and ideas to improve the process. Please respond on behalf of your own expertise, rather than on behalf of your organization. All responses will be kept secure and confidential.

If you decide to volunteer, you will be asked to complete 16 questions in a 15-20 minute online survey that is completed anonymously. Survey questions focus on your experiences and ideas to improve species at risk recovery planning and implementation in Canada.

Participation in this study is voluntary. You may decline to answer any questions that you do not wish to answer, and you can withdraw your participation at any time by not submitting your responses. Partially completed survey responses that are submitted will be included in the analysis."

There are no known or anticipated risks from participating in this study. Your identity will be confidential. All of the data will be summarized, and no individual could be identified from these summarized results.

You will be completing the study by an online survey operated by Qualtrics. Qualtrics has implemented technical, administrative, and physical safeguards to protect the information provided via the Services from loss, misuse, and unauthorized access, disclosure, alteration, or destruction. However, no Internet transmission is ever fully secure or error free. Qualtrics temporarily collects your computer IP address to avoid duplicate responses in the dataset but will not collect information that could identify you personally.

If you prefer not to submit your survey responses through this host, please contact Dan Kraus so you can participate using an alternative method such as through an e-mail or paper-based questionnaire. The alternate method may decrease anonymity, but confidentiality will be maintained.

The data, with no personal identifiers, collected from this study will be maintained on a password-protected computer database. As well, the data will be electronically archived after completion of the study and maintained for at least two years and then erased. Because this survey is anonymous, it will not be possible to remove your data from the study once their responses are submitted.

Questions and consent

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #44054). If you have questions for the Board, contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or reb@uwaterloo.ca.

If you have any questions about this study please contact Daniel Kraus: dtkraus@uwaterloo.ca, Faculty of the Environment, University of Waterloo. The faculty supervisor for this study is Stephen Murphy (stephen.murphy@uwaterloo.ca). You can also request that this survey be conducted over the phone or via email. If you are not completing the survey but would like to receive a copy of the results of this study, please contact either investigator.

Consent to Participant

By agreeing to participate in the study you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

[insert check box or radio button] "I agree to participate." (link to survey)

[insert check box or radio button] "I do not wish to participate (please close your web browser now)."

B. Let's hear about you.

1. What region of Canada best describes the primary focus of your work on species at risk recovery? (Please select all that apply)	• National • British Columbia • Alberta • Saskatchewan • Manitoba • Ontario • Quebec • New Brunswick • Nova Scotia • Prince Edward Island • Newfoundland and Labrador • Northwest Territories • Nunavut • Yukon • I only work outside Canada (programming note: screen out)
2. Which of these categories best describes your involvement in species at risk recovery? (Please select all that apply)	• Author (someone who writes recovery documents) • Contributor (someone whose knowledge/ research on species at risk is used in recovery planning, or reviews recovery documents) • Researcher (someone who studies recovery documents) • Practitioner (someone who directly implements recovery documents) • Manager (someone who manages the writing or implementation of recovery documents) • Other (specify)
3. What is your main taxonomic expertise? (Please select all that apply)	• Amphibians • Arthropods • Birds • Fishes (freshwater) • Fishes (marine) • Lichens • Mammals (marine) • Mammals (terrestrial)

	• Molluscs • Mosses • Reptiles • Vascular Plants
4. Which of these categories best describes the organization you work for?	• Non-governmental organization • Federal government • Indigenous community • Provincial or Territorial government • Municipal government • Academic institution • Consulting firm • Self-employed • Other, please specify

C. Tells us about your experience in developing and implementing recovery plans.

5. Approximately how many years have you been involved in species at risk recovery documents?	• 0-5 • 6-10 • 11-20 • 21-30 • 30+
6. How many recovery documents for species at risk have you been an author or contributor (approximately)?	• Text entry
7. Have you also contributed to Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessments as a COSEWIC member, writer, or reviewer?	• Yes • No

D. Let's explore your expectations about the potential effectiveness of recovery plans and opportunities for improvement.

(programming note: answers randomized)

8. Select the statement that best characterizes your general prediction of the <u>impact</u> of recovery documents.	• If fully implemented, recovery documents will improve the status of the species (e.g., threatened to special concern). • If fully implemented, recovery documents will maintain the status quo of the species. • Even if the recovery document is fully implemented, the status of the species will decline.
9. Select the statement that best characterizes your	• Recovery documents will be fully implemented. • Recovery documents will be partially implemented.

general expectation on <u>implementation</u> of recovery documents.	• Recovery documents are unlikely to be implemented.
10. What could be done to improve the <u>process</u> of preparing a recovery document? (Please drag and rank your responses) (Programing note: pick, group and rank)	• Develop more concise recovery documents. • Combine recovery documents and action plans where feasible. • Limit overlap with COSEWIC assessments (e.g. species biology, threats). • Increased input from species experts. • More effective consultation with Indigenous communities. • Align approaches to recovery with the Open Standards for the Practice of Conservation. • Bigger budget to complete schedule of studies, identified recovery actions and other identified research gaps. • More effective consultation with local communities and stakeholders. • Bigger budget to complete studies and identify recovery actions. • Only map critical habitat for species that are range-restricted or threatened by habitat loss. • Other, please specify (free text)
11. What could improve the <u>implementation and effectiveness</u> of a recovery document? (Please drag and rank your responses) (Programing note: pick, group and rank)	• More specific and measurable objectives (e.g. population and distribution objectives) and strategies (e.g. implementation measures). • More ambitious objectives and strategies. • Better collaboration across the SARA cycle (e.g. include thresholds that are needed to improve the COSEWIC status assessment). • More grouping of species into ecosystem-based and multi-species recovery document. • More focus on community engagement actions. • More engagement of Indigenous communities. • More detailed mapping and/or descriptions of critical habitat. • More focus on abating greatest threats. • More evidence-based assessment of threats. • More focus on managing cumulative effects. • More focus on actions that are based on conservation evidence. • More focus on climate change adaptation. • More focus on translocations. • Improve linkages between funding programs and priority recovery actions. • Faster development of action plans. • More regular reporting on recovery plan progress. • More engagement of social scientists and science communicators to develop key messages and engagement strategies.

	• More resources for implementation. • Other please specify (free text)
12. Given limited resources, how do you think species should be prioritized for recovery planning?	• Species at greater risk (i.e., based on COSEWIC assessment) • Species with the highest threats. • Newly listed species (over updating existing recovery plans). • Species that mostly occur outside of protected areas. • Species that are not covered by existing federal or provincial conservation laws (e.g. Migratory Birds Convention Act). • Species that are unlikely to benefit from existing recovery actions for other species. • Species that are most likely to benefit from recovery actions. • Species that are more likely to benefit multiple other species when recovery actions are implemented. • Species that nationally endemic to Canada • Species that are at greatest risk of extinction. • Other, free text
13. How should species recovery be measured?	• Any improvement in COSEWIC status (including the discovery of new populations). • Only improvements in COSEWIC status that are the result of a genuine change in the biological condition of the species. • Population trends that are consistent with recovery plan population and distribution objectives or management objectives. • Other (free text)
14. Do you have any other suggestions to improve recovery planning?	• Open text
15. Is there anything not covered in the survey questions that you would like us to know?	• Open text

E. Are you interested in the results?

16. If you like to be informed of the results of the survey, please email dtkraus@uwaterloo.ca and a copy will be provided.	• Submit button
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Feedback and appreciation message

Thank you for participating in our survey on recovery planning for species at risk in Canada. Your feedback is extremely valuable.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB [44054]). If you have questions for the Board, contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or reb@uwaterloo.ca.

For all other questions or if you have general comments or questions related to this study, please contact: Daniel Kraus, University of Waterloo, School of Environment, Resources and Sustainability, Faculty of Environment, dtkraus@uwaterloo.ca

S2. Results for questions 10-12 (multiple choice)

Q10 - 10. What could improve the process of preparing recovery documents?

Field	Min	Max	Mean	Standard Deviation	Variance	Responses	Sum
Develop more concise recovery documents.	1.00	4.00	2.27	0.91	0.82	103	234.00
Combine recovery documents and action plans where feasible.	1.00	4.00	1.81	0.86	0.74	102	185.00
Limit overlap with COSEWIC assessments (e.g., species biology, threats).	1.00	4.00	2.45	0.77	0.60	103	252.00
Increased input from species experts.	1.00	4.00	2.07	0.80	0.65	103	213.00
More effective consultation with Indigenous communities.	1.00	4.00	2.09	0.91	0.82	105	219.00
Align approaches to recovery with the Open Standards for the Practice of Conservation.	1.00	4.00	2.76	1.10	1.20	104	287.00
More effective consultation with local communities and stakeholders.	1.00	4.00	2.09	0.81	0.66	104	217.00
Bigger budget to identify critical habitat and fill research gaps.	1.00	4.00	1.72	0.85	0.73	103	177.00
Only map critical habitat for species that are range-restricted or threatened by habitat loss.	1.00	4.00	2.49	0.92	0.84	102	254.00
Other, please specify	1.00	4.00	1.55	1.09	1.19	38	59.00

Q11 - 11. What could improve the implementation and effectiveness of recovery doc...

Field	Min	Max	Mean	Standard Deviation	Variance	Responses	Sum
More specific and measurable objectives (e.g., population & distribution objectives) and strategies (e.g., implementation measures).	1.00	4.00	1.60	0.70	0.49	103	165.00
More ambitious objectives and strategies.	1.00	4.00	2.21	0.91	0.83	102	225.00
Better collaboration across the SARA cycle (e.g., include thresholds that are needed to improve the COSEWIC status assessment).	1.00	4.00	1.94	0.97	0.94	104	202.00
More grouping of species into ecosystem-based and multi-species recovery documents.	1.00	4.00	1.96	0.84	0.71	104	204.00
More focus on community engagement.	1.00	4.00	2.04	0.75	0.57	102	208.00
More detailed mapping and/or descriptions of critical habitat.	1.00	4.00	2.13	0.81	0.65	103	219.00
More focus on abating greatest threats.	1.00	3.00	1.22	0.44	0.19	103	126.00
More evidence-based assessment of threats.	1.00	4.00	1.75	0.81	0.65	103	180.00
More focus on managing cumulative effects.	1.00	4.00	1.73	0.79	0.63	103	178.00
More focus on actions that are based on conservation evidence.	1.00	4.00	1.52	0.72	0.52	103	157.00
More focus on climate change adaptation.	1.00	4.00	2.05	0.79	0.62	104	213.00
More focus on translocations.	1.00	4.00	2.87	0.78	0.62	103	296.00
More engagement of social scientists and science communicators to develop key messages and engagement strategies.	1.00	4.00	1.99	0.80	0.64	104	207.00
More resources for implementation.	1.00	3.00	1.18	0.46	0.21	103	122.00
More engagement of Indigenous communities.	1.00	4.00	2.06	0.78	0.61	104	214.00
Improve linkages between funding programs and priority recovery actions.	1.00	4.00	1.39	0.63	0.39	103	143.00
Faster development of action plans.	1.00	4.00	1.76	0.82	0.67	103	181.00
More regular reporting on recovery plan progress.	1.00	4.00	2.12	0.80	0.64	105	223.00
Other, please specify	1.00	4.00	1.71	1.22	1.49	28	48.00

Q12 - 12. Given limited resources, how do you think species should be prioritized...

Field	Min	Max	Mean	Standard Deviation	Variance	Responses	Sum
Species at greater risk (i.e., based on COSEWIC assessment).	1.00	4.00	1.60	0.81	0.66	104	166.00
Species with the highest threats.	1.00	4.00	1.61	0.92	0.85	104	167.00
Newly listed species (over updating existing recovery plans).	1.00	4.00	2.34	0.97	0.93	104	243.00
Species that mostly occur within protected and conserved areas.	1.00	4.00	2.70	0.62	0.38	104	281.00
Species that are already covered by existing federal or provincial conservation laws (e.g., Migratory Birds Convention Act).	1.00	4.00	2.59	0.74	0.55	103	267.00
Species that are unlikely to benefit from existing recovery actions for other species.	1.00	4.00	2.08	0.88	0.78	104	216.00
Species that are most likely to benefit from recovery actions.	1.00	4.00	1.60	0.86	0.74	104	166.00
Species that are more likely to benefit multiple other species when recovery actions are implemented.	1.00	4.00	1.49	0.78	0.62	104	155.00
Species that nationally endemic to Canada.	1.00	4.00	1.54	0.80	0.64	103	159.00
Species that are at greatest risk of global extinction.	1.00	4.00	1.27	0.62	0.39	105	133.00
Other, please specify	1.00	4.00	2.14	1.30	1.69	14	30.00