



WWF

CANADA



LIVING PLANET REPORT CANADA

2020 • WILDLIFE AT RISK

WWF-Canada's Living Planet Report Canada 2020: Wildlife At Risk could not have been developed without the expertise, analytical skills and contributions of several individuals.

Jessica Currie, James Snider and Emily Giles led the analysis as part of WWF-Canada's Science, Knowledge and Innovation (SKI) team. Core principles and conceptual design of the Living Planet Index (LPI) were originally developed by the Zoological Society of London and World Wildlife Fund International.

Special thanks for contributions from Eli Enns, Danika Littlechild, George Russell Jr. and Paul Okalik.

Special thanks for review and support to: Karen Beazley (Dalhousie University), Valentina Marconi (Zoological Society of London), Louise McRae (Zoological Society of London), Sarah Otto (University of British Columbia), Risa Smith (IUCN, WCPA), Eric B. Taylor (University of British Columbia) and Stephen Woodley (IUCN).

WWF-Canada. 2020. Living Planet Report Canada: Wildlife At Risk. Currie J. Snider J. Giles E. *World Wildlife Fund Canada*. Toronto, Canada.

WWF-Canada
4th Floor, 410 Adelaide Street West
Toronto, Ontario M5V 1S8

© 1986 Panda symbol WWF-World Wide Fund for Nature (also known as World Wildlife Fund).

® "WWF" is a WWF Registered Trademark.

WWF-Canada is a federally registered charity (No. 11930 4954 RR0001), and an official national organization of World Wildlife Fund for Nature, headquartered in Gland, Switzerland. WWF is known as World Wildlife Fund in Canada and the U.S. Published (September 2020) by WWF-Canada, Toronto, Ontario, Canada. Any reproduction in full or in part of this publication must mention the title and credit the above-mentioned publisher as the copyright owner. © Living Planet Report Canada: Wildlife At Risk (2020) WWF-Canada. No photographs from this production may be reproduced. All rights reserved. wwf.ca

Living Planet Report® and Living Planet Index® are registered trademarks of WWF International.

Cover photo: © Shutterstock

Living Planet Report Canada is
generously supported by the



Patrick and Barbara
Keenan Foundation



© Brad Josephs

CONTENTS

CHAPTER 1: REVERSING WILDLIFE LOSS IN CANADA	9
What is the Living Planet Index?	11
What is in the Canadian Living Planet Index?	12
Where do the data come from?	12
Treatment of data	14
Analytical updates for the 2020 Canadian Living Planet Index	14
Embracing different knowledge systems	15
CHAPTER 2: CANADIAN LIVING PLANET INDEX	19
Understanding the national trend	24
Shifting baselines	27
A focus on at-risk species	28
CHAPTER 3: NATIONALLY ASSESSED AT-RISK SPECIES	31
Canadian LPI for nationally assessed at-risk species	32
CHAPTER 4: IDENTIFICATION OF THREATS	35
Interacting drivers of decline	36
Overexploitation	39
Land use and land-use change	46
Sea use and sea-use change	48
CHAPTER 5: GLOBALLY ASSESSED AT-RISK SPECIES	51
Canadian-LPI for globally assessed at-risk species living in Canada	52
CHAPTER 6: SOLUTIONS THAT ADDRESS MULTIPLE THREATS	63
Nature-based climate solutions	64
Protection and management of habitats and carbon stores	65
Protected areas	66
Indigenous protected and conserved areas	70
Stewarding protected and conserved areas	72
Ecological restoration of degraded ecosystems	74
Moving forward	78
REFERENCES	80

MESSAGE FROM MEGAN LE

When it comes to nature, Canada is considered a land of plenty — plenty of ocean coastline and boreal forest; plenty of sea ice and grasslands; and plenty of winding rivers, sparkling lakes and expansive wetlands. While it's true that we have a lot of intact ecosystems throughout our vast and beautiful country — the second-largest amount remaining in the world, in fact — plenty is a relative term. Plenty has not proven to be enough for all wildlife to thrive.

Our Living Planet Report Canada (LPRC) 2020 reveals that since 1970, populations of Canadian species assessed as at risk have plunged by an average of 59 per cent and species assessed as globally at risk have seen their Canadian populations fall by an average of 42 per cent.

Past solutions have addressed one problem at a time, and we know now that this hasn't been enough — as our new report shows, at-risk species now face multiple threats. We need new approaches to address them simultaneously. Industrial pressures and overexploitation, for example, are threatening wildlife across our lands and waters. The climate crisis is wreaking ever more havoc, with fires and floods raging regularly across the south as the Arctic melts and the seas rise. And the resulting habitat loss and degradation are driving both species declines and land-based emissions.

It's no easy feat to tackle all of this at once. But nature can inherently help us fight this dual crisis of climate change and biodiversity loss. Our ecosystems can sequester carbon and safeguard species — all we have to do is protect and restore these areas and let them do their jobs.

And we already know how to do it. Indigenous knowledge systems and leadership are effective and just keys to successful conservation. Protected areas, ecosystem restoration and sound

management are proven to help species recover. And nature-based climate solutions not only mitigate the effects of a warming world — they also safeguard wildlife at the same time by providing the habitat they need to thrive.

Here at WWF-Canada, we're committing our resources, re-organizing our activities and re-aligning our operations as part of a 10-year concentrated effort to achieve greater sustainability of wildlife populations and healthy ecosystems for both nature and people.

But we can't accomplish this alone. It's easy to get discouraged by bad news about the environment, especially with COVID-19 putting the world into even more of a tailspin. But post-pandemic green recovery plans can provide a rare opportunity to not just imagine the future we want to live in, but also to fund it. And when we all come together — as individuals, organizations, communities, governments and businesses — we can effect real change with innovative and inspiring solutions. Through the LPRC 2020, we've shown that we have the knowledge and expertise required to reach these goals. By joining forces, we will achieve them.

Megan Leslie
President and CEO
World Wildlife Fund Canada





A DIFFERENT APPROACH TO CONSERVATION IS NEEDED: ONE THAT CAN MORE EFFECTIVELY ADDRESS MULTIPLE THREATS TO BIODIVERSITY AND CANADA'S ECOSYSTEMS, INCLUDING THE ACCELERATING CLIMATE CRISIS

MESSAGE FROM JAMES SNIDER

We are at a pivotal moment in time. Over just the past year, we've seen wildfires raging through the Amazonian rainforest and all across Australia, while the Arctic's sea ice melts and permafrost thaws. Climate change is not some far-off problem for the future. The consequences are here — now — and already having frightening impacts.

We've also seen a series of publications from the scientific community on the astonishing magnitude of the challenge ahead of us. UN scientific panel reports have shown as many as one million species are at risk of future extinction and that the destruction and degradation of nature is a key driver of climate change, causing as much as 30 per cent of current greenhouse gas emissions.

As this Living Planet Report Canada 2020 shows, we are confronting these staggering challenges here as well. The Canadian Living Planet Index reveals that populations of our at-risk species are in dramatic decline due to multiple threats to their survival. The results clearly indicate we need to be doing much more to address these threats — and we need to be doing it now.

We're also seeing our world transformed by the catastrophic consequences of the COVID-19 pandemic, which at its roots has deep connections to the degradation of habitat and increased risk of transference of zoonotic diseases that pass from wildlife to humans.





THE RESULTS CLEARLY INDICATE WE NEED TO BE DOING MUCH MORE TO ADDRESS THESE THREATS – AND WE NEED TO BE DOING IT NOW

In a world in crisis, we must reconsider our relationship with nature and invest in solutions that simultaneously tackle the deeply interwoven threats of climate change and biodiversity loss.

There is an urgent need for Canada to embrace this opportunity. We have a responsibility to demonstrate global leadership. We can show the world how nature-based climate solutions — like protecting intact nature and broad-scale

restoration of degraded habitats, both of which sequester carbon — can be implemented in a just and equitable way through Indigenous-led conservation. This will help us build a stronger, more resilient future for wildlife, climate and people.

James Snider
Vice-president, Science, Knowledge and Innovation
World Wildlife Fund Canada



© Shutterstock

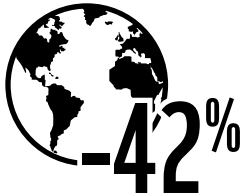
KEY FINDINGS



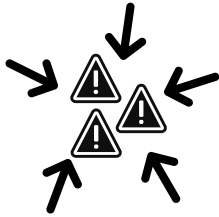
Populations of Canadian species assessed as at risk nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) have declined by 59 per cent, on average, from 1970-2016.



At-risk species in Canada face an average of five threats, including the accelerating threat of climate change.



Populations of species of global conservation concern — assessed as threatened on the IUCN Red List — also have declined in Canada by 42 per cent, on average, from 1970-2016.



Conservation efforts targeting single threats are unlikely to be successful, so new approaches tackling multiple threats are needed to stop wildlife loss in Canada.



Nature-based climate solutions — like protected areas and restoration — can help to stop this wildlife loss by addressing multiple threats to biodiversity while reducing climate change by sequestering and storing carbon in natural ecosystems.





REVERSING WILDLIFE LOSS IN CANADA: A NEW WAY FORWARD

Canada is widely renowned for its rich, abundant ecosystems. These forests, tundra, sea ice, watersheds, grasslands and marine and coastal zones provide habitat for approximately 1,800 native species of vertebrate animals¹.

Recently, Canada was identified as being second in the world (behind only Russia) when it comes to remaining intact natural landscapes² (particularly boreal forests and tundra)³ and seascapes.⁴ Canada, therefore, has a disproportionate opportunity and responsibility to protect these land and seascapes — providing important habitat for wildlife, including endemic, native and migratory species.

And yet...

Canada is now home to hundreds of at-risk species. Without meaningful conservation action, their decline will

continue. The WWF-Canada Living Planet Report Canada (LPRC) 2020 has analyzed wildlife population trends and found that **populations of Canadian vertebrate species currently assessed as at risk nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) have seen their numbers plummet by 59 per cent, on average, from 1970 to 2016.** While some of these species were assessed as at risk due to declining population sizes, in aggregate, this trend clearly indicates that efforts to protect and recover vulnerable wildlife at local, provincial and national

scales are not nearly enough.

Wildlife in Canada are threatened by multiple, interacting drivers of decline, including overexploitation of resources and the accelerating threat of climate change. **In fact, species currently assessed as at risk in Canada by COSEWIC face an average of five threats.**

Conservation actions that target only single drivers of wildlife and habitat decline will be insufficient to reverse biodiversity loss. Increasingly, conservation strategies need to embrace systematic and multifaceted approaches that tackle multiple environmental crises at the same time.

Canada is not only home to wildlife of national conservation concern — it also hosts species of global conservation importance. In our study, **populations of vertebrate species currently assessed as at risk globally by the International Union for Conservation of Nature (IUCN) have declined, on average, by 42 per cent in Canada from 1970 to 2016.** These declines of species of global conservation concern in Canada magnify our international responsibility for their recovery.

Canada's ecosystems — habitats for globally and nationally threatened wildlife — also provide key goods and services that we — humans — rely on, such as food, medicines, and clean air and water. They even capture and store greenhouse gases that affect our climate. In fact, significant amounts of the world's carbon are sequestered and stored in Canada's wetlands, peatlands, coastal areas and forests. Yet with the continued degradation of nature, Canada's ecosystems have lost stored carbon since the 1990s, and Canada's significance as a carbon sink, particularly in forests, has been declining.⁵ It's clear that Canada also bears a global responsibility to prevent the release of these carbon stores into the atmosphere and enhance the ecosystems' absorption capacities to help address the accelerating threat of climate change.

This is why **a different approach to conservation is needed: one that can more effectively address multiple threats to biodiversity and Canada's ecosystems,**

including the accelerating climate crisis.

Nature-based climate solutions are one example. Through the protection, stewardship and restoration of ecosystems with large amounts of stored carbon or high carbon sequestration rates, we can support critical natural carbon sinks while simultaneously conserving wildlife of national and global conservation concern.

WWF-Canada's LPRC 2020 findings demonstrate the need for immediate action and heightened ambition. The next decade will be critical in reversing catastrophic wildlife loss and climate breakdown. Canada can — and must — provide global leadership by strengthening its goals and commitments at home and showing the world the way forward for nature and people.



INTERPRETING THE LIVING PLANET INDEX

The C-LPI is an indicator of wildlife abundance over time and does not reflect species extinctions. In addition, an average of population trends is not synonymous with an average of total numbers of animals lost. For instance, a loss of 20 to 10 individuals in a population would have the same proportional loss as a decline of 10,000 to 5,000 but the total number of animals lost differs substantially.

WHAT IS THE LIVING PLANET INDEX?

The Living Planet Index is a biodiversity indicator used to track the state of wildlife at global, national or local scales. It is used to measure ecological performance by tracking patterns in vertebrate abundance (population size) over time. The Living Planet Index is based on one of the largest repositories of vertebrate abundance data over time. It was adopted by the Convention on Biological Diversity (CBD) as an indicator to track progress towards its targets aimed at addressing biodiversity loss.⁶

Canadian invertebrates are not included within the Canadian Living Planet Index (C-LPI) as only a small fraction of invertebrate species have consistent long-term monitoring data available for analysis. Consequently, the gap in representation would inaccurately reflect the state of invertebrate species across the country. In contrast, vertebrates are comparatively well monitored and 50 per cent of native vertebrate species are currently represented in the C-LPI.

Globally, the Living Planet Index was first published in 1998 and has been updated biennially to track average population abundance of monitored vertebrate species over time.⁷ The C-LPI was first released by World Wildlife Fund (WWF) Canada in 2007,⁸ with a single, yet substantial update published in 2017.⁹ In 2017, both WWF-Canada and Environment and Climate Change Canada (ECCC)¹⁰ adopted modified versions of the global Living Planet Index to monitor aggregate trends in vertebrate abundance. These modified versions, titled the C-LPI and the Canadian Species Index (CSI) respectively, showcasing similar national and realm-level results.

KEY TERMS

BIODIVERSITY (short for “biological diversity”): The variability among living organisms, from plants to animals, and the terrestrial, marine and freshwater ecosystems in which they live. Biodiversity includes diversity within the same species (genetic diversity), between different species and between ecosystems.

LIVING PLANET INDEX (LPI): An indicator of biodiversity that tracks patterns of vertebrate abundance over time. Trends in abundance indicate how well nature is doing overall.

POPULATIONS (short for “monitored populations”): Refers to the wildlife population data included in the Canadian Living Planet Index Database. A single species may be made up of many different monitored populations that all contribute to the average trend for that species. For example, wood turtles are found in Ontario, Quebec, New Brunswick and Nova Scotia and the population trends in these various locations all contribute to the species’ national trend. In this report, monitored populations and populations are used interchangeably.

TAXONOMIC GROUPS: In biology, species are grouped together into taxonomic groups based on shared characteristics. For the Canadian Living Planet Index, species are grouped into the four different vertebrate groups: birds, mammals, fish, and amphibians and reptiles.

WHAT IS IN THE CANADIAN LIVING PLANET INDEX?

WHERE DO THE DATA COME FROM?

Data on trends in species populations were obtained from over 300 sources and included in the calculation of the 2020 Canadian Living Planet Index (C-LPI). Data were retrieved from peer-reviewed scientific literature, public databases and government assessments (for example Fisheries and Oceans Canada Research Vessel Trawl Surveys and North American Bird Conservation Initiative — Canada’s State of Canada’s Birds¹¹). Approximately half of Canada’s native vertebrate species (883 species) were included within the C-LPI, and the data quality, spatial coverage and number of populations differed by species and taxonomic group. The data had broad spatial coverage across the country (Figure 1), particularly for marine fish and birds.

- Criteria for the inclusion of species population data in the index followed the approach of previous iterations of the Living Planet Index as developed by the Zoological Society of London,¹² WWF-Canada¹³ and ECCO,^{14 15} with slight modifications for the C-LPI:
- Populations must have been consistently monitored in the same location, using the same method over time;
- Data must be numerical (i.e., a population count or another reliable population-size proxy such as population estimates, spawning stock biomass, density, etc.);

- Data sources must be referenced and traceable;
- Species must be native to Canada and have applicable conservation status rank according to Canada’s Wild Species Report¹⁶ (i.e., exotic species, hybrids and accidental species under the NatureServe rank of “not applicable” were excluded); and
- Population data must be available for at least three years between 1970 and 2016 (previously, only two years of data were required).



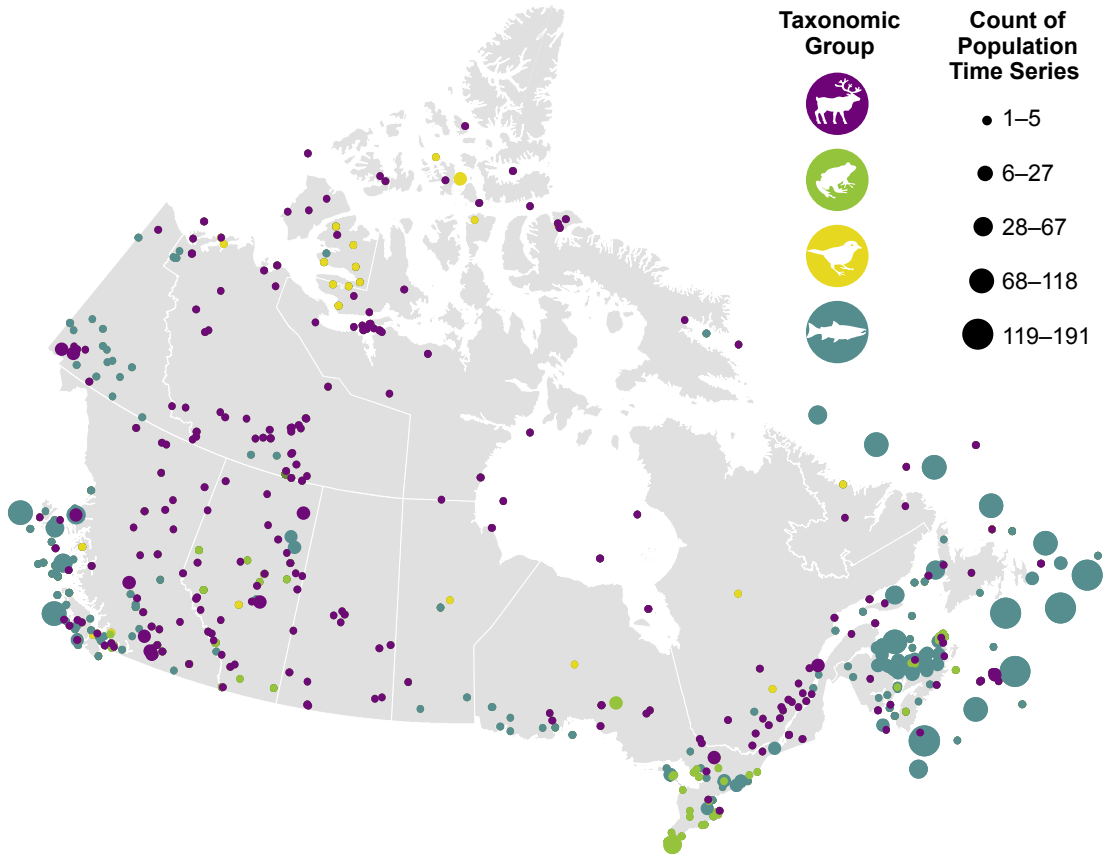
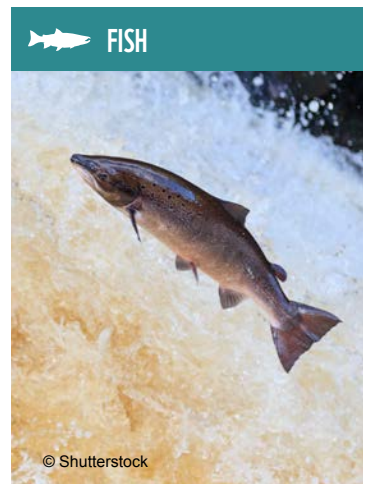


Figure 1. Distribution of the 3,415 population trends from the Canadian Living Planet Index. Point locations — which include some provincial-level data points — provide a rough indication of the distribution of the data. A point location may correspond to several monitored populations and/or species. Note that 366 population trends corresponding to nation-wide bird trends are not shown on this map as they lack spatial specificity.



TREATMENT OF DATA

In cases where there was spatial overlap of population time series for a given species, only one of the overlapping populations was retained to reduce geographic sampling bias. Priority for inclusion was given to higher quality data, which encompasses time series length, fullness, and credibility of the data source.

In calculating the C-LPI, population counts of zero — where a species was not observed in a given year — were treated as missing values, as they are more likely missing observations than representing local population extirpations.¹⁷ Critically, none of the population time series included in the C-LPI had a zero (or trailing zeroes) recorded as the final numeric data point for the trend and were therefore not reflective of a true extinction.

ANALYTICAL UPDATES FOR THE 2020 CANADIAN LIVING PLANET INDEX

In the 2020 report, we have strengthened our analysis by requiring higher standards for data quality and by collecting additional data, including more recent data records. Notably, a large portion of new data came from Fisheries and Oceans Canada in Newfoundland, and Parks Canada (where increases in wildlife populations are anticipated). Due to these methodological and database changes, the C-LPI should be viewed as the best possible snapshot of trends in Canadian wildlife populations at a given time and should not be directly compared to previous iterations of the index.

DETAILED CHANGES INCLUDE:

- The addition of new data spanning various time periods between 1970 and 2016;
- An extension of the index from 2014 to 2016; and
- Changes in the criteria for inclusion in the analysis, requiring data of greater quality (time series fullness) to produce a more accurate picture of the state of wildlife in Canada. Population data must be available for at least three years between 1970 and 2016 (only two years of data were previously required).

See [WWF-Canada's C-LPI Technical Supplement](#) for additional details.

EMBRACING DIFFERENT KNOWLEDGE SYSTEMS



© Andrew S. Wright / WWF-Canada

Embracing Indigenous-led conservation is vital to advancing reconciliation and renewing relationships with Indigenous Peoples. First Nations, Métis and Inuit have been stewarding these lands and waters for millennia. Supporting Indigenous knowledge, governance, sovereignty and leadership is essential to advancing reconciliation and conservation across the country.

For conservation in Canada to be equitable and just, we need to increasingly recognize different knowledge systems — both Indigenous and non-Indigenous — and how they can contribute to the understanding of nature and our human relationship with nature. The C-LPI itself is part

of a scientific knowledge system that relies on a specific form of quantitative data.

To expand our consideration of other vital ways of knowing in the LPRC 2020, we have included a series of species stories to further explore trends in wildlife in Canada told from the perspective of both Indigenous and non-Indigenous knowledge systems. This is one step towards WWF-Canada’s journey toward embracing “two-eyed seeing” — which includes learning to see and embrace the strengths of Indigenous knowledges from one eye, and the strengths of scientific knowledge from the other.¹⁸

ETHICAL SPACE AND BIODIVERSITY CONSERVATION



BY: DANIKA LITTLECHILD, ASSISTANT PROFESSOR, LAW AND LEGAL STUDIES, CARLETON UNIVERSITY, ERMINESKIN CREE NATION, MASKACIS, TREATY NO. 6 TERRITORY, CO-CHAIR, INDIGENOUS CIRCLE OF EXPERTS

I grew up on the reserve and from an early age was hyper aware of what we would now call biodiversity and its connection to Cree knowledge systems and culture.

From a young age, one of my uncles would come and pick me up and take me out into the bush behind our house to walk to my grandma's place. On the way, he would show me traditional medicines and different plants until I was probably about nine or 10.

Around that time, things changed quite drastically — the First Nation that I lived in started giving out leases to non-Indigenous farmers who cleared the land near our house. They also started using herbicides and pesticides that would have an impact on our local biodiversity and our ability to harvest traditional food. At the same time, there was a huge amount of oil and gas extraction also happening on the reserve.

Today, when I take the same path behind my family home, it's all crabgrass. We used to have a slew of plants there. They're totally gone. We used to be able to pick berries very close to our house. All of that has gone away. There's really no biodiversity left.

Before I served on the Indigenous Circle of Experts (ICE), I worked with other experts on the concept of ethical space. Ethical space is about elevating Indigenous systems to a position of equity. There is a common refrain that conservationists would use when they would talk about Indigenous Peoples in protected areas, or their rights and roles in conservation. With ICE, we wanted to shift

everyone out of that default mode and elevate Indigenous systems to a position of equity with non-Indigenous systems, and have Indigenous Peoples be recognized as experts of their own knowledge systems. We didn't want a scenario where we needed non-Indigenous scientists or experts to "translate" what we would say to make it legitimate somehow.

This allows both systems to function on their own and with their own integrity without having to alter themselves. Conservation issues go through these respective systems and are brought into ethical space for "cross-validation."

As we move toward important biodiversity targets, it's a lot easier to meet a rapidly approaching target using well-established organizations as opposed to working with First Nations that have limited capacity. But we need to provide as much support as we can to those Indigenous nations who wish to take a different approach within their territories. We should be flexible in terms of understanding the different iterations that can happen around a protected and conserved area led by Indigenous people.

And finally, it's important to recognize and pause and celebrate when we do make progress together. The ICE report is a good example of this. All our actions add up to something because they open up new avenues of thought and new ideas of how to approach things and they have a ripple effect for relationships and how we communicate.



**“ETHICAL SPACE IS ABOUT
ELEVATING INDIGENOUS
SYSTEMS TO A POSITION
OF EQUITY”**

- DANIKA LITTLECHILD



© Jachan Devol

CANADIAN LIVING PLANET INDEX

The Canadian Living Planet Index (C-LPI) examines the average trend in population abundance for 883 native vertebrate species in Canada — about half of Canada’s vertebrate species¹⁹ — and shows a **near-stable trend of six per cent from 1970–2016** (from 1.0 in 1970 to 1.06 in 2016; Figure 2a). The confidence intervals overlap the baseline.

Birds and fish are the primary taxonomic groups in the C-LPI, accounting for 44 per cent and 41 per cent of species in the analysis, respectively (Figure 2b). The relative proportion of mammals (11 per cent) and amphibians and reptiles (four per cent) is smaller (Figure 2b). This is expected, given that there are comparatively fewer species in these taxonomic groups in Canada (Table 2). Taxonomic biases also exist in the broader context of conservation research with fish, amphibians and reptiles often underrepresented relative to the number of species in these groups.²⁰

HOW TO READ THE INDEX

The Living Planet Index was assigned a benchmark value of 1.0 in 1970. An increase in the index represents an increase in wildlife population abundances and would be presented as an upward trend in the index value over time. The magnitude of the change in the Living Planet Index can be reported as a percentage — if the index value increases from 1 to 1.2, that’s an increase of 20 per cent. The opposite is true for decreases in abundance: a decrease from 1 to 0.8 is a decrease of 20 per cent. Any finding within five per cent of the baseline is considered stable.

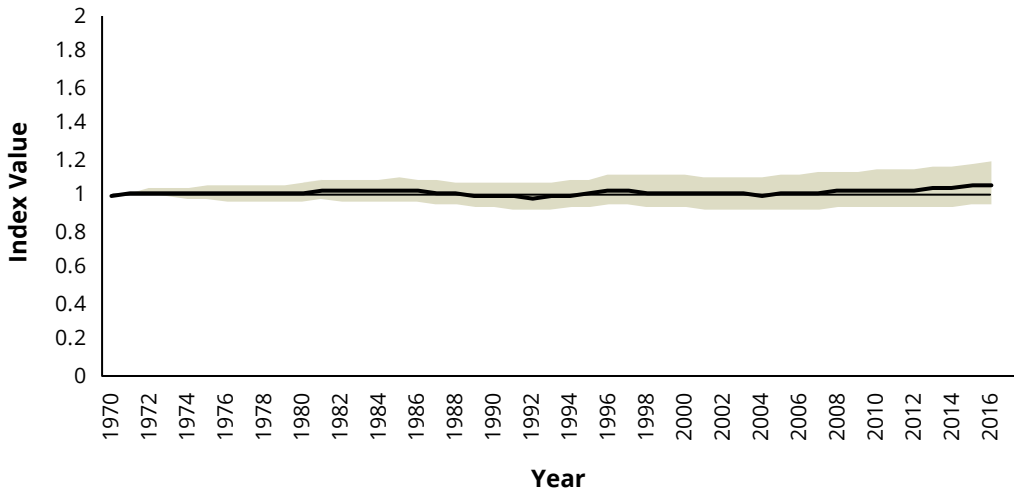


Figure 2a. The Canadian LPI shows an average near-stable trend of six per cent (confidence interval range: -5 to 19 per cent) between 1970 and 2016. Trend in population abundance for 3,781 population time-series of 883 native vertebrate species.

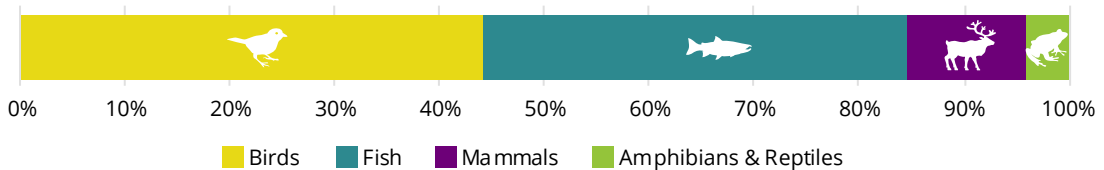


Figure 2b. Relative proportion of taxonomic groups included in the analysis (883 species).





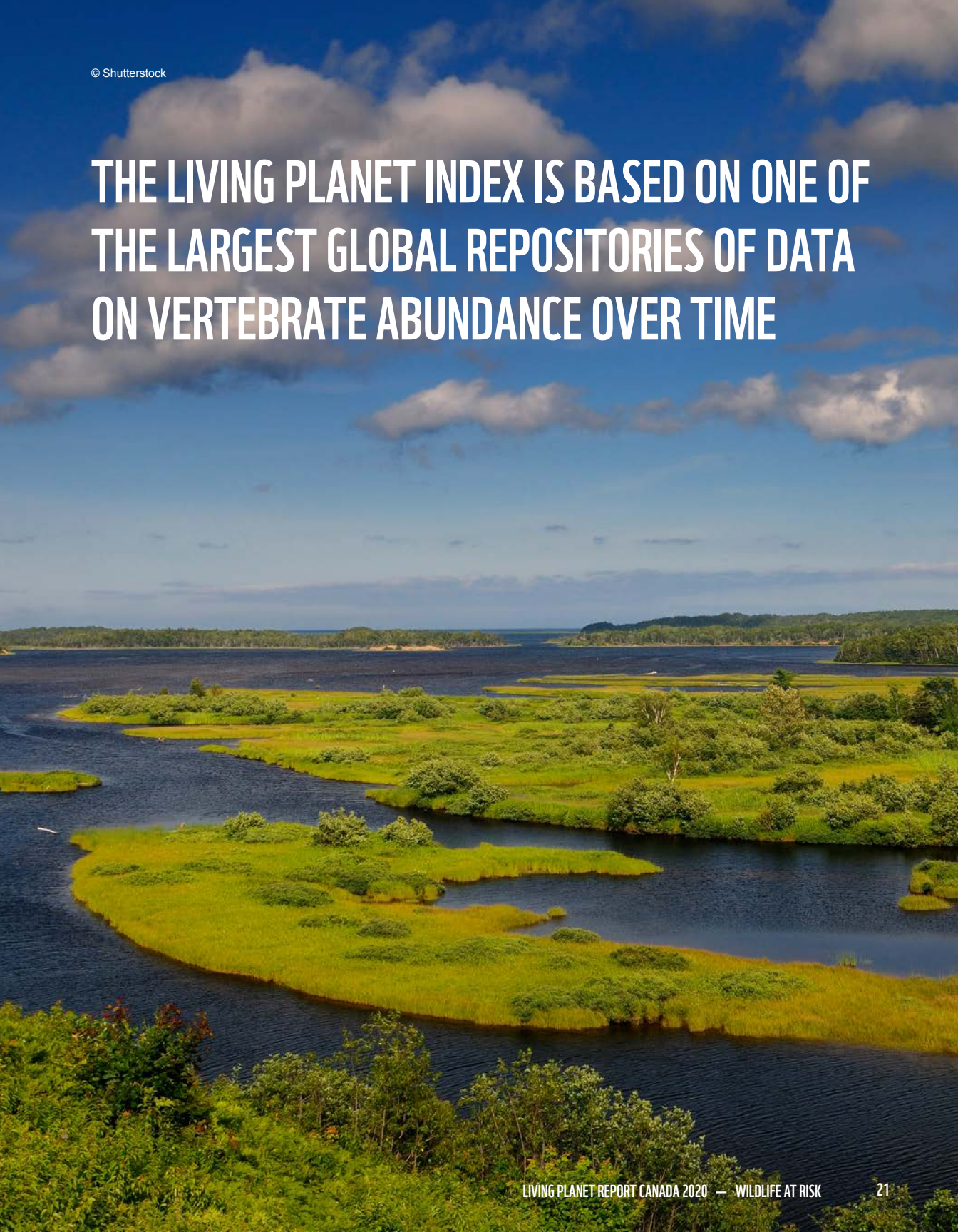
Taxonomic Group	Number in C-LPI	Number in Canada	Percentage Included
	389	452	86%
	357	1,043	34%
	100	196	51%
	37	87	43%
Total	883	1,778	50%

Table 2. Representation of native vertebrate species considered of conservation interest according to Canada's [Wild Species Report](#)²¹ (exotic species, hybrids and accidental species are excluded) included in the analysis.

THE LIVING PLANET INDEX IS BASED ON ONE OF THE LARGEST GLOBAL REPOSITORIES OF DATA ON VERTEBRATE ABUNDANCE OVER TIME



SHORTNOSE STURGEON (*Acipenser brevirostrum*)

COSEWIC Status: **Special Concern**

IUCN Red List Status: **Vulnerable**

Shortnose sturgeon are a prehistoric-looking fish species that have been around for millions of years. In Canada, they are only found in the Saint John River system in New Brunswick. The small range of the Canadian shortnose sturgeon population makes it vulnerable to potential threats within the Saint John River system. They occupy estuarine (where marine meets freshwater) habitats.²²

Shortnose sturgeon are heavily armoured — they have large bony plates covering the lengths of their bodies and barbels (feelers that look much like whiskers)

extending from their mouths. They are long-lived — the oldest female ever recorded in the Saint John River was 67 years old — and females are reproductively mature when they are 18 years old, typically spawning once every three years.²³ The shortnose sturgeon is one of only five sturgeon species in Canada. Although a population size estimate for the whole river has not been completed since 1979, **the population at the only confirmed overwintering site has been stable over the last ten years.**²⁴



PEREGRINE FALCON

(*Falco peregrinus anatum/tundris*)

COSEWIC Status: Not at Risk
IUCN Red List Status: Least Concern

Peregrine falcons tell a success story about how conservation efforts can have astounding effects on wildlife. But it wasn't always this way. Like many other birds of prey, peregrine falcon populations plummeted in the mid-20th century following the introduction of the pervasive pesticide known as DDT (dichlorodiphenyltrichloroethane). For many birds, the pesticide caused their eggshells to thin, ultimately lowering their reproductive success.²⁵

In response to environmental and human health concerns, most uses of DDT were restricted in North America in the mid-1970s, and the chemical was entirely phased out by 1990.²⁶ But by then, the population of peregrines had become so depleted, the birds needed additional species-specific conservation actions to aid in their recovery — specifically, captive breeding and reintroduction.²⁷ As a result, peregrine falcons (*Falco peregrinus anatum/tundris*) dramatically increased in abundance since the 1970s. They're now considered Not at Risk by COSEWIC.²⁸



UNDERSTANDING THE NATIONAL TREND

The Canadian Living Planet Index is an average of trends in abundance for monitored vertebrate populations over time. Importantly, the aggregated overall trend is a composite of both increasing and decreasing trends in vertebrate populations of varying magnitude and frequency. For example, wolverines in southern and eastern Canada have generally declined in abundance, yet they've exhibited more stable trends in the territories and may even be increasing in central Canada (northern Ontario and Manitoba).²⁹ Nonetheless, wolverines in Canada have been collectively assessed as Special Concern, as they are particularly sensitive to human disturbance, and increasingly threatened by habitat fragmentation, harvest pressure and climate change.³⁰

Closer examination of the C-LPI data reveals that 415 of the 883 (47 per cent) vertebrate species included in the analysis declined in abundance from 1970 to 2016 (Figure 2c). By contrast, 48 per cent (427 of 883) of species have increasing trends on average, and five per cent (41 of 883) are considered stable (within five per cent of the baseline) (Figure 2c). The equal split of increasing and declining trends is anticipated to some degree, showcasing some form of equilibrium for the diverse set of ecosystems within Canada. Still, anthropogenic activity has considerably shifted the

natural equilibrium of ecosystems, resulting in a catastrophic loss of species and in some cases, significant increases. Some wildlife populations have reported declining trends of nearly 100 per cent (e.g., Northern bobwhite and little brown bat), while others have increased by similar or greater proportions (e.g., trumpeter swan). It's important to note that a species can only decline by 100 per cent but can increase boundlessly. For instance, geese have increased by 360 per cent in Canada.³¹ Some species whose populations are increasing were the focus of large-scale policy changes, such as harvest bans (e.g., humpback whale), protected area establishment (e.g., whooping crane) and elimination of persistent organic pollutants (e.g., peregrine falcon); others, such as raccoons, striped skunks and coyotes, simply fare well in human-built environments; and further species benefited from more targeted conservation action at local scales (for example captive breeding and reintroduction as well as habitat restoration).



© Erwin Hesry

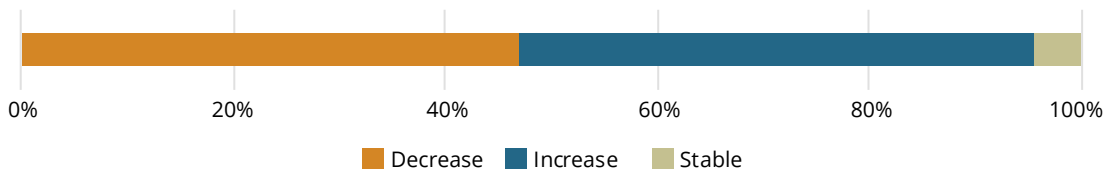
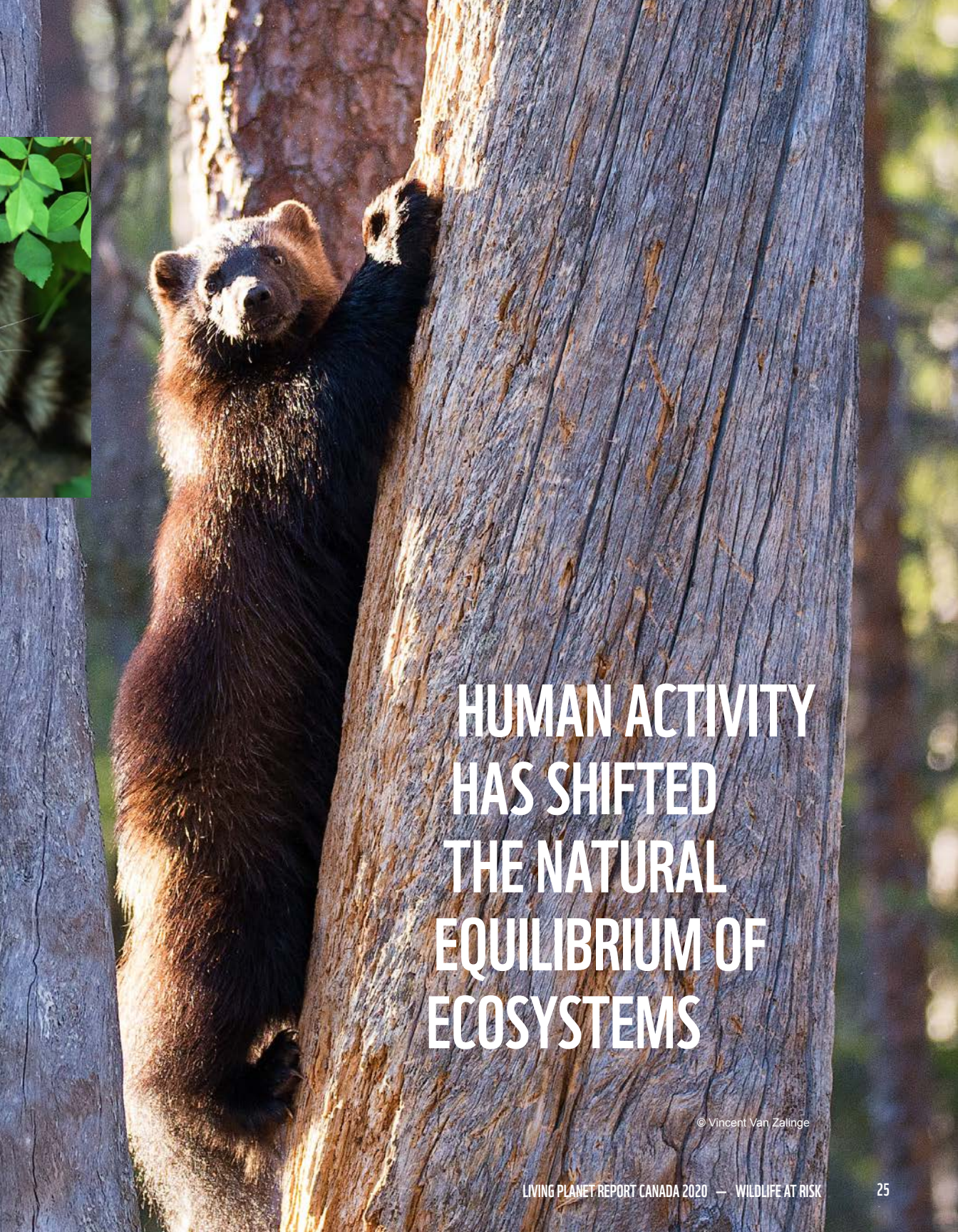


Figure 2c. Relative proportion of species with decreasing, increasing and stable trends.



HUMAN ACTIVITY HAS SHIFTED THE NATURAL EQUILIBRIUM OF ECOSYSTEMS

© Vincent Van Zalinge

HUMPBACK WHALE

(*Megaptera novaeangliae*)

COSEWIC Status: Not at Risk/Special Concern

IUCN Red List Status: Least Concern

Commercial whaling depleted humpback whale populations, which were prized for their blubber, in the early 20th century. To deal with overharvesting while accounting for migratory behaviour and global distribution, the humpback whale became legally protected under two international conventions. **Commercial harvesting of humpbacks was banned in 1955 in the North Atlantic and in 1966 in the North Pacific.**³²

These international efforts and national protection measures in both Canada and the US have helped to reverse the decline of humpback populations. While humpbacks still face several threats, including vessel strikes, entanglement in fishing gear and noise pollution,³³ the introduction of legislation and international cooperation helped to save the species from the brink of extinction in the mid-20th century.





SHIFTING BASELINES

The “shifting baseline syndrome” coined by Daniel Pauly³⁴ notes that the baseline by which we judge and determine population trends affects our perception of the state of ecosystems. We perceive a loss relative to the standard that we set, and consequently lose the knowledge of a less disturbed historical state — meaning that we’re adjusting baselines to new levels dependent upon the current state of wildlife, but are unable to recall how our ecosystems flourished historically.

In the C-LPI, we use a benchmark year of 1970 as the basis of our analysis of trends in wildlife populations. This is largely due to limited data availability before that date. In interpreting the results of the C-LPI, the timeframe of 1970 to 2016 represents a comparatively small and recent analysis of the trends in Canada’s wildlife populations. For some of the species included in the C-LPI, the baseline year of 1970 may capture

a period of especially low population numbers — an increase from 1970, then, doesn’t necessarily mean the population has reached its historical level. For instance, swift foxes were declared extirpated (locally extinct) in Canada in the 1970s, but through dedicated captive breeding and reintroduction programs the swift fox population had grown to 647 by 2009. Yet, despite an increase in abundance since 1970, the species is still considered Threatened due to its small population size and highly restricted distribution.³⁵ The use of 1970 as a baseline year, then, may not fully represent the complete picture of wildlife trends in Canada. The consideration of historical trends (i.e., a baseline prior to 1970) is likely to reflect a greater loss of wildlife in Canada — consistent with the growing evidence that biodiversity, globally, is declining faster than at any other time in human history.³⁶

A FOCUS ON AT-RISK SPECIES

Biodiversity is important for the health and resiliency of ecosystems and the critical planetary services they provide. The loss of a single, keystone species — one that has a disproportionately large effect on the natural environment — can have detrimental effects throughout the ecosystem. At WWF-Canada, it's our responsibility as a conservation organization to focus on those species that are in decline — an approach that's needed to prevent the imminent loss of species in Canada (either local extirpation or global extinction). According to the data underlying the C-LPI, there

are a greater number of populations experiencing more substantial rates of decline than those with more moderate and incremental declines. (For more information on this analysis, please refer to [WWF-Canada's C-LPI Technical Supplement](#).) Understanding the magnitude and rate of decline of these species is crucial for evaluating the impact of wildlife threats, identifying the necessary conservation actions for their recovery and tracking progress against international biodiversity goals.



© Kevin Schafer/WWF



**WE ARE IN A
GLOBAL BIODIVERSITY CRISIS.
IN RESPONSE, THIS REPORT FOCUSES
ON SPECIES AT RISK OF EXTINCTION TO
BETTER UNDERSTAND THEIR POPULATION
TRENDS AND THE INCREASING THREATS
THEY FACE IN CANADA**



© Shutterstock

NATIONALLY ASSESSED AT-RISK SPECIES

The 2017 LPRC focused on species legally listed under Canada’s federal Species at Risk Act (SARA), and found continued declines in these wildlife populations during the period of 2002–2014, despite protections under the Act.³⁷ In this 2020 report, we take a broader look at species of conservation concern in Canada by examining trends in wildlife populations that are scientifically assessed as being at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

COSEWIC is an independent advisory panel to the Minister of the Environment and Climate Change Canada. It has been operating since 1977 but was legally established as an advisory body under SARA in 2003. The committee uses the best available scientific and Indigenous knowledge to assess species against the criteria for the following statuses: Extinct, Extirpated, Endangered, Threatened, Special Concern, Not at Risk or Data Deficient. COSEWIC meets biannually to evaluate the status of candidate species — Canadian plants and animals — based on expert advice. Evaluations consider several biodiversity elements including trends in

population size, spatial distribution and threats.³⁸ Species categorized as Special Concern, Threatened and Endangered are considered to be at risk of extinction.³⁹

There is a crucial difference between COSEWIC-assessed and SARA-designated species: while some species may be scientifically identified as meeting the criteria of being imperiled or in need of dedicated conservation efforts for recovery, only a subset of those species are officially recognized and assigned protections by the federal legislation. In some cases, the difference between these two groups of at-risk species can be attributed to the

SARA listing process itself, which has often seen significant delays between scientific assessments and species receiving legal protections under the Act. However, the pace of SARA listing of COSEWIC-assessed at-risk species has considerably improved over the last four years.⁴⁰ In addition, differences between these two groups of at-risk species can be attributed to systemic biases in the SARA listing process — particularly for fish species threatened with overexploitation, which often do not receive protections under the federal Act.⁴¹

While it is anticipated that the LPI for this group of species is likely to exhibit a declining trend, it is important to gain insight into the magnitude of the decline. An understanding of the extent of declines in this broader group of COSEWIC-assessed at-risk species is key to determining appropriate conservation efforts, rather than focusing solely on those that have received legal protections to date under SARA.

CANADIAN LPI FOR NATIONALLY ASSESSED AT-RISK SPECIES

The Canadian Living Planet Index (C-LPI) for nationally assessed at-risk species in Canada shows that **populations have declined, on average, by 59 per cent between 1970 and 2016** (from 1.0 in 1970 to 0.41 in 2016; Figure 3a). The index includes 629 populations of 139 COSEWIC-assessed at-risk vertebrate species — representing just over half of at-risk vertebrate species in Canada. Results suggest that the decline is consistent across species groups (birds, fish, mammals, and amphibians and reptiles) (Figure 3b). The average trend includes species that are both increasing (30 per cent) and decreasing (68 per cent) in abundance (Figure 3c). The index is reflective of species currently assessed as at risk and does not include species that have improved in population size to the point where they are no longer considered at risk (<15 species in the dataset) or those that have gone extinct.

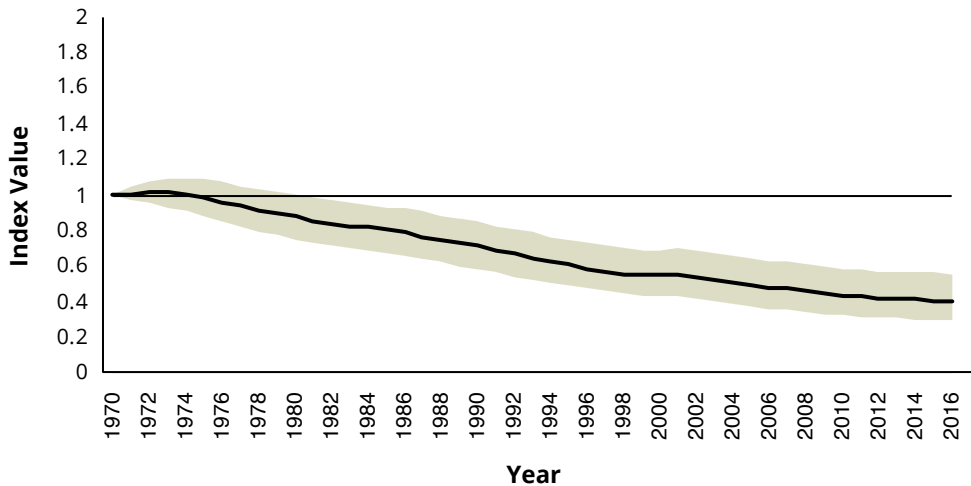


Figure 3a. The C-LPI of COSEWIC-assessed at-risk species in Canada shows an average decline of 59 per cent (confidence interval range: -70 to -44 per cent) between 1970 and 2016. Trend in population abundance for 629 population time-series of 139 native vertebrate species. The *Species at Risk Act* was enacted in 2002.

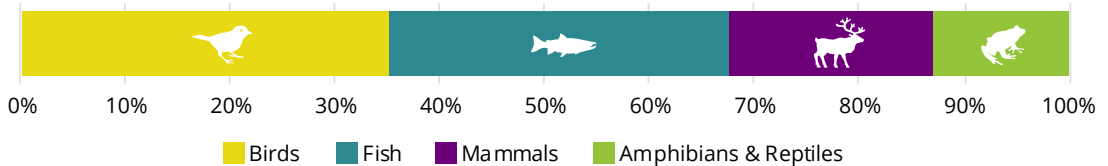


Figure 3b. Relative proportion of taxonomic groups included in the analysis (139 species).

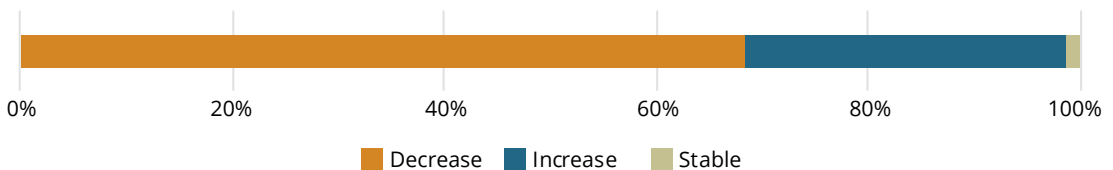


Figure 3c. Relative proportion of species with decreasing, increasing and stable trends.

In addition to creating a C-LPI specific to nationally assessed at-risk species, a C-LPI was created for species that had been assessed by COSEWIC but were not considered at risk. Species assessed as Not at Risk by COSEWIC were evaluated and found not to be at risk of extinction given current trends in population abundance and distribution. Populations of species classified

as Not at Risk have increased by 82 per cent on average from 1970 to 2016 (see [WWF-Canada's C-LPI Technical Supplement](#)).



**UNDERSTANDING THE DRIVERS OF
EXTINCTION RISK IS KEY TO
DETERMINING APPROPRIATE
CONSERVATION EFFORTS**

© Andrew DuBois

IDENTIFICATION OF THREATS

Successful recovery of at-risk species is dependent on the effective mitigation of threats — the factors that are responsible for population declines.⁴² Despite our knowledge of the major drivers of species decline, many of them remain pervasive and have accelerated since 1970.^{43 44} Identifying and quantifying these threats can help guide conservation actions that maximize species recovery.

In 2008, IUCN released a Threats Classification Scheme (Version 3.2) to systematically identify the direct drivers of species declines.⁴⁵ The Threat Classification Scheme identifies the stressors — namely the industries (e.g., agriculture, forestry, fisheries, mining) and human infrastructural developments (e.g, roads, cities, dams) — that contribute to a given overarching threat (e.g., habitat loss and fragmentation) so that action may be directed accordingly. Threats that affect population trends can differ in their severity and may be historical, ongoing or emerging.

QUANTIFYING THREATS

The IUCN Threats Classification Scheme (Version 3.2) was used to categorize threats to COSEWIC-assessed at-risk species based on information from their respective COSEWIC Status Reports. The identified threats are specific to the Canadian context.

INTERACTING DRIVERS OF DECLINE

COSEWIC-assessed at-risk species are affected by multiple, cumulative pressures. These species have been impacted by five threats on average, with some variation among the taxonomic groups (Figure 4a). Generally, amphibians and reptiles were the most threatened taxonomic group, with many species in the group exposed to several different threat types — seven on average. Eighty-seven per cent of species were impacted by more than one threat. Recent research suggests that threats to species — particularly pollution — may be under-reported in COSEWIC reports⁴⁶ and therefore the threats analysis may represent a conservative evaluation of threats to wildlife in Canada.

Given that most populations, especially those designated as at risk of extinction, are affected by multiple stressors,⁴⁷ it is important to understand

the complexity of interacting drivers of population trends, recognizing that feedback loops may exist.⁴⁸ For instance, the western tiger salamander (prairie/boreal population) is most acutely affected by dams and water management, but is also impacted by other anthropogenic threats including pollution, invasive species, road mortality, climate change and agricultural activity.⁴⁹ The cumulative and cascading effects of these threats may be more detrimental than the individual threats — if a population is already facing habitat loss, this can be compounded by the effects of climate change, which may further restrict its range. Conservation actions that target only a single threat are unlikely to successfully stop and reverse wildlife declines as threats to species are often cumulative or synergistic and can have cascading effects.⁵⁰

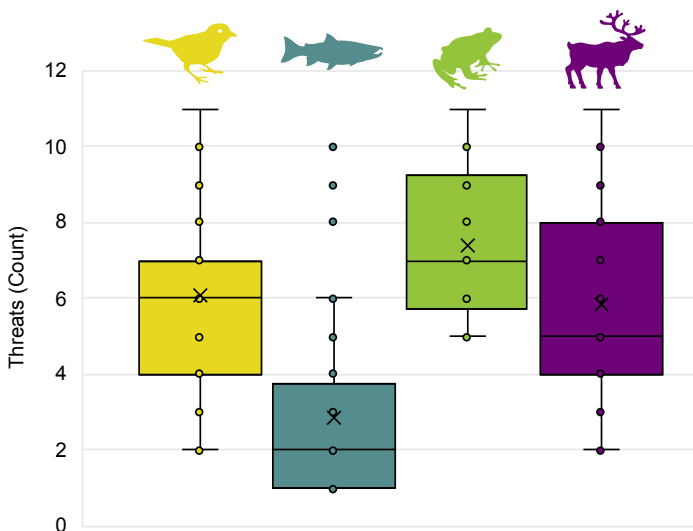


Figure 4a. Number of threats impacting COSEWIC-assessed at-risk species in Canada. Lines represent median values, and Xs represent average values. While the LPI includes 139 species, threat data were only available for 132 of these species.

WOOD TURTLE

(*Glyptemys insculpta*)

COSEWIC Status: **Threatened**

IUCN Red List Status: **Endangered**

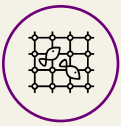
Wood turtles are semiaquatic freshwater turtles that inhabit both riparian (along the banks of rivers) and terrestrial habitats. As a long-lived species with a late sexual maturity, they are vulnerable to population changes. As a result, any adult mortality above the natural rate can dramatically cause population declines.

The species is impacted by several threats that have cumulatively led to an overall decline in abundance. In fact, the population faces nine of the eleven threat categories listed in its COSEWIC Status Report.⁵¹ While some of the listed threats are considered to have an overall low impact, together they have resulted in an overall high threat level for the wood turtle within Canada. Wood turtles are most acutely affected by agriculture and transportation

corridors, both of which cause habitat loss and direct mortality. Wood turtles prefer habitats with short vegetation (early successional habitat) for foraging and nesting, but may experience increased risks of mortality if these habitats are scarce and require travelling longer distances to find these habitats. As vegetation grows taller over time, wood turtles are forced to find areas with shorter vegetation and may risk more road crossings (which may lead to collisions with cars) or instead nest in agricultural fields (which may lead to collisions with tractors).⁵² They are also subject to illegal collection for the pet trade, forest harvesting, changes in stream flow, problematic native species and floods.⁵³



THREATS



OVEREXPLOITATION (OE): Exploitation of biological resources at unsustainable levels, including both deliberate and unintentional harvesting effects (e.g., bycatch). Includes unsustainable fishing, hunting, gathering and collecting, in addition to logging and wood harvesting.



INVASION AND DISEASE (ID): Invasive and other problematic species, genes and diseases.



POLLUTION (PO): Threats from the introduction of materials or energy from both point and non-point sources, including domestic and urban wastewater, industrial and military effluents, agricultural and forestry effluents, garbage and solid waste, air-borne pollutants, and excess energy (e.g., light, noise, etc.).



CLIMATE CHANGE (CC): Linked to global warming and other severe climatic events including droughts, floods, sea-level rise and tundra thawing.



URBAN DEVELOPMENT (UD): Human settlements (e.g., housing, offices, schools, etc.), factories and other commercial centers, and tourism and recreational sites.



TRANSPORT (TR): Transportation and service corridors and the vehicles that use them, including roads and railroads, utility and service lines, shipping lands and flight paths.



HUMAN DISTURBANCE (HD): Human activities that result in habitat loss and degradation including recreational activities and military exercises.



AGRICULTURAL ACTIVITY (AG): Agricultural expansion and intensification due to farming, ranching, silviculture, mariculture, aquaculture, and annual and perennial crops.



ENERGY PRODUCTION (EP): Exploration, development and production of minerals and rocks (mining and quarrying), petroleum and other liquid hydrocarbons (oil and gas drilling), and renewable energy.



SYSTEM MODIFICATION (SM): Modification of natural systems including fire and fire suppression, dams and water management, and other modifications to improve human welfare.



GEOLOGICAL EVENTS (GE): Catastrophic geological events including volcanoes, earthquakes, tsunamis, avalanches and mudslides.

**Based on the IUCN Threats Classification 3.2*

OVEREXPLOITATION

The most frequent threat facing COSEWIC-assessed at-risk species was overexploitation (Figure 4b) — this is particularly true for fish (Figure 4c), which is anticipated given that monitored fish populations included in the C-LPI are primarily those of commercial interest, and are thus far more likely to be overexploited. Overexploitation is the deliberate and/or unintentional harvesting of biological resources (flora and fauna) at unsustainable levels — activities such as logging, fishing and hunting. Unintentional or indirect overexploitation includes things like bycatch, where species (like turtles or sea birds) are unintentionally caught in a fishing net. Research suggests that overexploitation is also the most prevalent threat facing many at-risk species in Canada⁵⁴ and around the world (it is considered a “Big Killer”).⁵⁵

Many species that have been assessed as at risk by COSEWIC — particularly those that are harvested

for commercial or subsistence value^{56 57 58} such as fish or northern mammals — are frequently denied legal protection under the Species at Risk Act. The irony is that the greatest threat to Canadian wildlife — direct or in-direct harvest — is also frequently the rationale for not affording legal protections to ensure the long-term persistence of species. This bias in the SARA listing process has not improved over time.⁵⁹

To reiterate, the IUCN Threat Classification Scheme identifies industries and human infrastructural developments that contribute to an overarching threat so that action can be more appropriately directed. To that end, habitat loss caused by land use and land-use change (or sea use and sea-use change) is also a predominant driver of biodiversity loss that is embedded within most of the 11 threat categories.

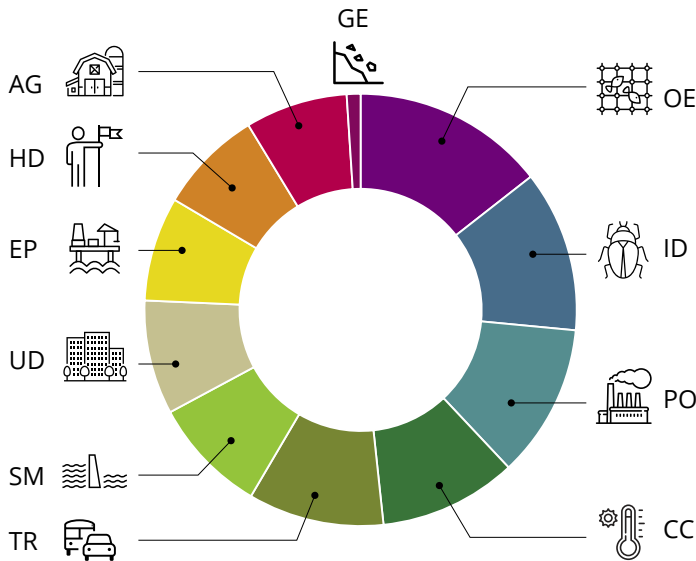


Figure 4b: Types of threats as a per cent of all threats faced by COSEWIC-assessed at-risk species in Canada. While the LPI includes 139 species, threat data were only available for 132 of these species.



Figure 4c. Proportion of COSEWIC-assessed at-risk species exposed to each of the 11 threat categories, organized by taxonomic group. A large surface area indicates that a taxonomic group is exposed to many threats. The closer a polygon is to a particular threat, the more species in the group are exposed to that threat. While the LPI includes 139 species, threat data were only available for 132 of these species.

LEATHERBACK SEA TURTLE

(*Dermochelys coriacea*)

© Jürgen Freund/WWF

COSEWIC Status: **Endangered**

IUCN Red List Status: **Vulnerable**

The primary threat to leatherbacks in Canadian waters is fishery bycatch.⁶⁰ This means they're incidentally captured or entangled in fishing gear through a variety of fisheries — leatherback mortality rates in the Canadian Atlantic are estimated at more than 20 per cent.⁶¹ Unlike other turtles, a leatherback sea turtle cannot retract its head or flippers into its shell, nor can it swim in reverse,⁶² which means it cannot extract itself from fishing gear.

Although conservation measures have been implemented to recover the leatherback sea turtle

population in Canada, including research, monitoring, and educational tools for handling entanglements,⁶³ there are still opportunities to improve the mitigation of fishery bycatch in Canadian waters by engaging the industry and policy makers to address entanglement risks such as gear changes.

Each year, leatherbacks migrate over 10,000 km from tropical nesting beaches to feeding areas in the coastal and offshore waters of Canada.⁶⁴ Canada has a responsibility to protect this species.



CLIMATE CHANGE

Climate change ranked fourth among all threats for COSEWIC-assessed at-risk species (affecting 53 per cent of all species), but it also intensifies and accelerates other drivers of extinction risk.⁶⁵ This speaks to the complexity of the synergistic effects of multiple threats. Climate change has been increasingly cited as a threat in recent COSEWIC Status Reports.⁶⁶

Over the last three decades, the Intergovernmental Panel on Climate Change (IPCC) has been providing scientific evidence of anthropogenic climate change by outlining its causes, consequences and possible mitigation and adaptation measures. Despite the evidence, human activity has continued to contribute to global warming, with greenhouse gas emissions increasing annually.⁶⁷ Between 1990 and 2018, Canada's emissions increased by nearly 21 per cent.⁶⁸

Recently, the IPCC released a Special Report detailing the impact of global warming to 1.5°C above pre-industrial levels (a lower-risk goal when compared to a 2°C increase) in the context of strengthening the global response to climate change. While half a degree may seem inconsequential, this change in average global temperatures can have profound consequences on the ecosystems that both humans and wildlife rely on. This is especially relevant given that Canada is currently warming at twice the global average. Northern Canada is experiencing even more dramatic increases in temperature — it's warming at three times the global rate⁶⁹ and

species such as the barren-ground caribou and narwhal, along with local communities, are being negatively impacted by the loss of sea ice and changing availability of food and water sources during migration times. Already, human activity is estimated to have caused a global increase of approximately 1°C above pre-industrial levels. But staying below 1.5°C globally will require an ambitious emissions reduction strategy that reaches net zero by 2050. The implementation of this strategy would require rapid and extensive transitions in urban infrastructure, industrial systems and energy and land use that are unprecedented in scale.⁷⁰



KEY TERMS

Blue carbon: Carbon stored in vegetated coastal areas — seagrass meadows and tidal marshes.

Carbon sinks: Natural ecosystems and species that actively absorb carbon dioxide from the atmosphere and store it. Carbon sinks generally encompass blue carbon (coastal ecosystems such as eelgrass beds and tidal salt marshes), above-ground carbon (visible vegetation on the landscape such as forests) and below-ground carbon (carbon stored in soils of peatlands, wetlands, boreal forests and grasslands).

Greenhouse gas (GHG) emissions: A gas that contributes to a greenhouse effect through the absorption of infrared radiation. Examples of GHGs include carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O).

Mitigate: In the context of climate change, mitigation refers to the reduction or prevention of greenhouse gas emissions.

Net-zero emissions: The balance of anthropogenic CO₂ emissions and removals, so that overall, no carbon is emitted without being removed.



© Nicklin/Minden Pictures NatGeo

COLLARED PIKA (*Ochotona collaris*)

COSEWIC Status: Special Concern

IUCN Red List Status: Least Concern

Collared pikas are small mammals that inhabit alpine areas, which are patchily distributed above the tree line. The Yukon, Northwest Territories and northwest British Columbia are home to over half the global distribution of this species (the remainder extends into Alaska).⁷¹ Collared pikas spend the summer collecting plants and storing them as hay piles in rock crevices to eat during the freezing months of winter.⁷² Due to this food hoarding, pikas do not hibernate, and instead stay warm by eating their food stores.⁷³

Unlike species occupying southern Canada, where human footprint is high, habitat disturbance is comparatively low throughout the collared pika's

range. **However, the northern, high-altitude, mountainous habitat of collared pikas is currently being altered by climate change — their primary threat, and one that is anticipated to accelerate and intensify over the long term.**⁷⁴ Collared pikas are considered indicators of climate change as they are sensitive to climate variability, including changes in temperature, precipitation and seasonality — factors that can reduce habitat suitability and availability by altering ecosystem composition, leaving them more susceptible to climate-induced mortality.⁷⁵ In the absence of rapid action on climate change, the species may become increasingly threatened with extinction.



© Shutterstock

ATLANTIC WALRUS

(*Odobenus rosmarus rosmarus*)

COSEWIC Status: Special Concern
IUCN Red List Status: Near Threatened



Atlantic walrus are massive marine mammals that weigh about as much as a minivan. They play a key role in the food web — walrus feed on mollusks and other animals on the ocean floor and they are scavenged upon by polar bears. Indigenous communities also rely heavily on the walrus as a food source. Unsustainable hunting led to the extinction of the walrus population occupying coastal habitats of the Atlantic provinces by the mid-1800s. Although the two remaining Atlantic walrus populations are considered to have relatively stable population trends, **climate change is anticipated to negatively impact the population.**⁷⁶

As the climate changes and as sea ice continues to shrink, human encroachments on Atlantic walrus habitat result in noise pollution and new routes for shipping and oil tankers are expected to open. This expansion of the human footprint and encroachment means that vessels are likely to pass more closely to the sensitive breeding, feeding and haulout (large congregation) areas of the Atlantic walrus

and their young calves. When these animals hear the low rumble of a distant boat or aircraft, they can become disoriented, which can cause them to panic, and even stampede, inadvertently trampling their young, injuring themselves and becoming easy targets for waiting predators. If it happens repeatedly, they may even abandon their habitats. While these threats are currently considered low, they are expected to accelerate over the next decade. As the climate continues to change, and more and more humans move in, these factors may also interfere with foraging, affect energy expenditures, impair thermoregulation and enhance stress levels.⁷⁷

In order to safeguard Atlantic walrus, industrial expansion in the Arctic must be prevented from encroaching into vulnerable habitats. Given their sensitivity to human disturbances, the species could also benefit from limiting noise pollution in order to limit their panic response.

© Wim van Passel/WWF

LAND USE AND LAND-USE CHANGE

Most of the eleven threat categories are and inherently tied to land use and land-use change — urbanization, development of coastal regions, and impacts from industrial sector activities such as energy production and mining. Several large-scale ecosystem disruptions in Canada are the result of historical land use and land-use change, such as the conversion of native prairie grasslands⁷⁸ and wetlands⁷⁹ for agricultural use. More recent pressures showcase the persistent threat of land-use change, including an expansion of residential, commercial and industrial areas, and transportation infrastructure in Canada.⁸⁰ The loss, disruption or fragmentation of ecosystems and habitats have contributed to wildlife declines, particularly for rare species (those with small ranges or population densities), species with narrow habitat requirements,⁸¹ and migratory species.

Species richness (or the number of different species in an area) is strongly linked to climate, and in Canada that means many species are concentrated in the southern portion of the country, where they reach their northern limits.⁸² Key hotspots of at-risk species are evident in southern Ontario and Quebec, the Prairie grasslands, and the Okanagan

region in southern British Columbia,^{83 84} which are warmer areas also characterized by intensive land use and high human footprint.⁸⁵ The extent of spatial overlap between human activity and biodiversity is important in determining threats to wildlife⁸⁶ and ultimately, extinction risk.⁸⁷

Biodiversity is affected by compounding pressures. Climate change intensifies stresses on land and inland waters, acting as a catalyst of environmental change.⁸⁸ As a result, species are rapidly shifting to higher elevations and latitudes in search of suitable habitat in the face of high levels of climate warming.⁸⁹

In addition, the effects of climate change, such as increased forest fires, have actually amplified climate warming through positive feedback loops. **The loss and degradation of ecosystems through both land-use change and climate change releases carbon into the atmosphere, further accelerating the climate crisis.** Globally, nearly one quarter of total net anthropogenic greenhouse gas emissions come from agriculture, forestry and other land uses.⁹⁰ Improved land management can help alleviate land-use change and further conversion of important carbon stores.⁹¹

BURROWING OWL

(*Athene cunicularia*)

COSEWIC Status: **Endangered**
IUCN Red List Status: **Least Concern**

Burrowing owls — which nest in abandoned burrows of small mammals like prairie dogs, ground squirrels and badgers — have faced habitat loss and degradation of their native grasslands, which has been accompanied by declines in small mammals and suitable burrows. **In addition to habitat loss, new and emerging threats may be compounding population declines**, such as a decrease in annual summer fallow of Canada's croplands.⁹² Storms and flooding caused by climate change, vehicle collisions, predation and reduced prey availability from environmental contaminants are also to blame.⁹³

In Canada, burrowing owls breed in the prairies and the interior of British Columbia and the persistence of the population is largely a result of conservation actions such as captive breeding and reintroduction, habitat protection and creation programs, and land stewardship.⁹⁴ But with such a small population remaining (burrowing owls now occupy half of their 1970s breeding range and have been reduced to roughly 270 individuals in Canada⁹⁵), continued action is needed to reverse threats and prevent the species from becoming extirpated (or locally extinct) from Canada.



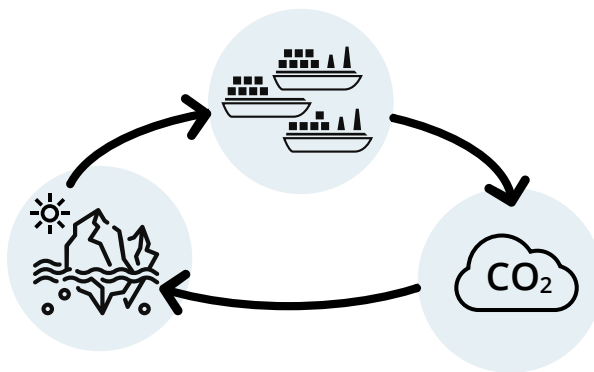
SEA USE AND SEA-USE CHANGE

Oceans also play an important role within the climate system in addition to providing services such as food, renewable energy, trade and transportation.⁹⁶ We have taken advantage of many of these services, some of which present multiple threats to wildlife.

Marine transportation is one example. While shipping can have direct impacts on wildlife (for example, vessel strikes), it can also contribute to habitat loss and degradation through oil spills, contaminants and noise pollution. In addition to threatening biodiversity, these anthropogenic impacts can also erode important coastal ecosystems that are critical to absorbing GHG emissions for climate regulation.

While we often think about carbon being stored on land, it's also stored in the oceans as “blue carbon” in coastal ecosystems, including seagrass beds and salt marshes.⁹⁷ The effects of climate change, such as diminishing Arctic sea ice, have actually amplified climate warming through positive feedback loops.⁹⁸ As this ice continues to melt — negatively affecting species that are highly dependent on sea-ice habitats for access to food or migration — we can also expect to see increased traffic in this sensitive marine environment, showcasing the compounding effects of multiple drivers.

As Arctic ice melts, a higher number of vessels can access the waters, which increases emissions and ultimately exacerbates the climate crisis:



NORTH ATLANTIC RIGHT WHALE

(*Eubalaena glacialis*)

COSEWIC Status: **Endangered**
IUCN Red List Status: **Critically Endangered**

The North Atlantic right whale is an example of how interacting threats — including the indirect effect of climate change — can negatively affect species abundance. Right whales are extremely dependent on copepods (tiny crustaceans) and follow them wherever they're highly concentrated — in this case, from the Bay of Fundy to the Gulf of St. Lawrence.

The problem is that **oceanographic shifts from climate change have shifted the endangered whales⁹⁹ to an area that, prior to 2017, did not have measures in place to reduce threats such as ship strikes and entanglement in fishing gear.** Previous conservation effort went into moving shipping lanes and protecting North Atlantic right whales' critical habitat in coastal waters off Nova Scotia and in the Bay of Fundy,¹⁰⁰ where they historically congregated. In the Gulf of St. Lawrence — an area the whales are increasingly frequenting — their vulnerability to these threats has dramatically increased in recent years.¹⁰¹

In 2017, an unprecedented 12 whales were recorded dead in Canadian waters.^{102 103} In rapid response, Fisheries and Oceans Canada is working to minimize potential entanglements through a variety of fishery closures throughout the Gulf of St. Lawrence.¹⁰⁴ Similarly, Transport Canada implemented mandatory and voluntary speed restriction zones to operate at a maximum of 10 knots for all larger vessels in the Gulf of St. Lawrence¹⁰⁵. (Preliminary analysis shows that the majority of ships were not complying with trial voluntary speed restriction in the Cabot Strait in May 2020.¹⁰⁶)

Right whales were also historically vulnerable to hunting (their name comes from the fact that they were considered the “right” whale to hunt because of their slow speed and vulnerability). Estimated to once have had a population of thousands, the species was hunted to the brink of extinction as a result of commercial whaling, and although the population has been protected from whaling since 1935, their survival continues to be threatened.¹⁰⁷ As of 2018, only 411 North Atlantic right whales remain.¹⁰⁸

© Brian J. Skerry National Geographic Stock/WWF



TRENDS IN ABUNDANCE AND EXTINCTION RISK OF A SPECIES CAN BE DIFFERENT AT THE LOCAL, NATIONAL OR GLOBAL LEVEL

© Shutterstock

GLOBALLY ASSESSED AT-RISK SPECIES

The International Union for Conservation of Nature’s Red List of Threatened Species is the world’s most comprehensive source of information on the global conservation status of biodiversity. To date, IUCN has assessed over 120,000 species around the world, nearly 27 per cent of which are threatened with extinction.¹⁰⁹

The IUCN Red List of Threatened Species, often referred to as the “Barometer of Life,” assesses population trends, geographic range, habitat availability, and current and emerging threats to determine the status of a species. IUCN categorizes threatened species in order of extinction risk from Vulnerable to Critically Endangered — the latter are species which are of greatest conservation concern from a global perspective such as the Vancouver Island marmot and leatherback sea turtle.

Because the IUCN Red List of Threatened Species is global, trends in abundance and extinction risk of the same species can be different at the national or local level. Consequently, while COSEWIC-assessed species were anticipated to be in decline, the same hypothesis does necessarily not hold true for IUCN Red-Listed species within Canada.

Species in Canada that are Threatened on the IUCN Red-List may be faring well within the country, but poorly around the globe. According to the IUCN Red List of Threatened Species, there are just over 100 globally threatened vertebrates with ranges in Canada. Yet, despite being at risk globally, some of these species, such as the Atlantic puffin, are faring well within Canadian borders. Others, such as caribou, have seen their numbers plummet below historic minimums despite management interventions, with some herds experiencing more drastic declines in Canada than anywhere else in the world.¹¹⁰ Canada has a national and shared global responsibility to contribute to the protection and recovery of globally at-risk species — especially as a country with a large portion of the world’s remaining areas of high ecological integrity.¹¹¹

CANADIAN-LPI FOR GLOBALLY ASSESSED AT-RISK SPECIES LIVING IN CANADA



© Shutterstock

The Canadian Living Planet Index (C-LPI) for globally assessed at-risk species shows that populations living in Canada have **declined by 42 per cent, on average, since 1970** (from 1.0 in 1970 to 0.58 in 2016; Figure 5a). The trend includes 316 populations of 51 species that are categorized as globally threatened on the IUCN Red List. Many of the species included in the index are iconic animals, including the Atlantic puffin and Atlantic walrus. Fish contributed the greatest proportion of species (43 per cent) — and therefore influence — to the average trend (Figure 5b), which is consistent with the rise (1970s) and collapse (1980s) of major fish stocks such as Atlantic cod. Most mammals were from the

marine environment, and there were only three reptiles included, all of which were turtles. While the majority (61 per cent) of these species are in decline, approximately 37 per cent are increasing in abundance (Figure 5c).

In addition to creating a C-LPI specific to globally assessed at-risk species in Canada, a C-LPI was created for species that had been assessed by the IUCN but are currently not classified under a threatened category, such as the grey wolf or Canada lynx. Population sizes of species classified as Lower Risk, Near Threatened and Least Concern have increased by 12 per cent on average from 1970 to 2016 (see WWF-Canada's C-LPI Technical Supplement).

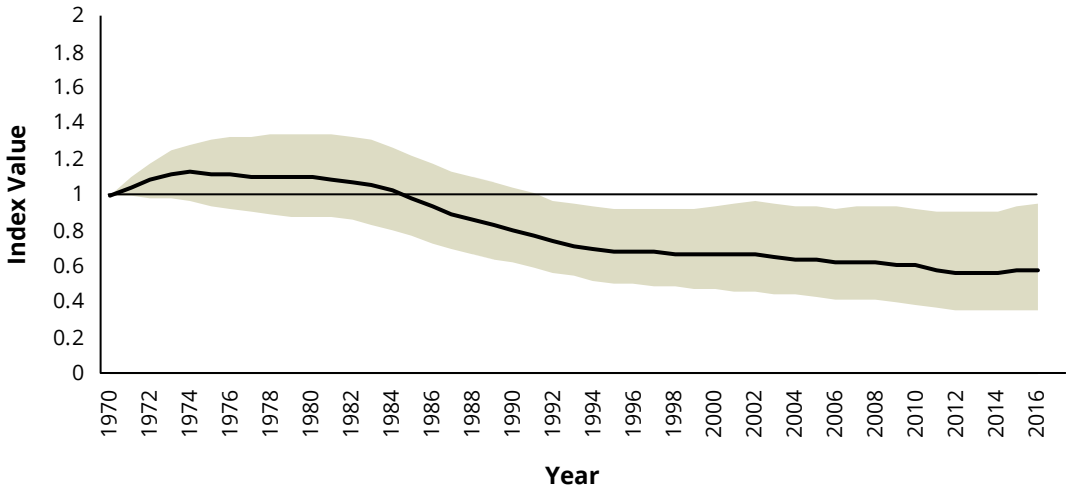


Figure 5a. The C-LPI of globally assessed at-risk species living in Canada shows an average decline of 42 per cent (confidence interval range: -64 to -5 per cent) between 1970 and 2016. Trends in population abundance for 316 population time-series of 51 native vertebrate species.

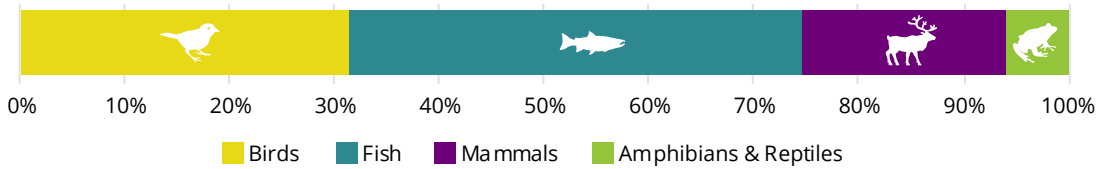


Figure 5b. Relative proportion of taxonomic groups included in the analysis (51 species).

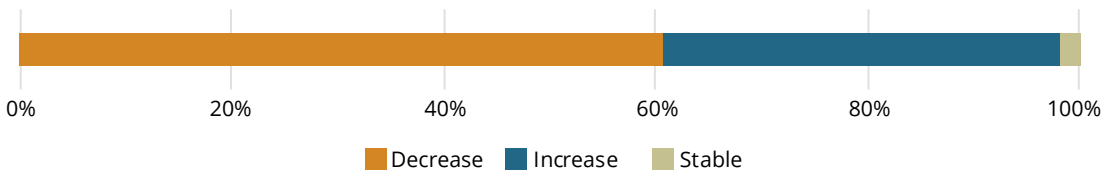


Figure 5c. Relative proportion of species with decreasing, increasing and stable trends.

VANCOUVER ISLAND MARMOT

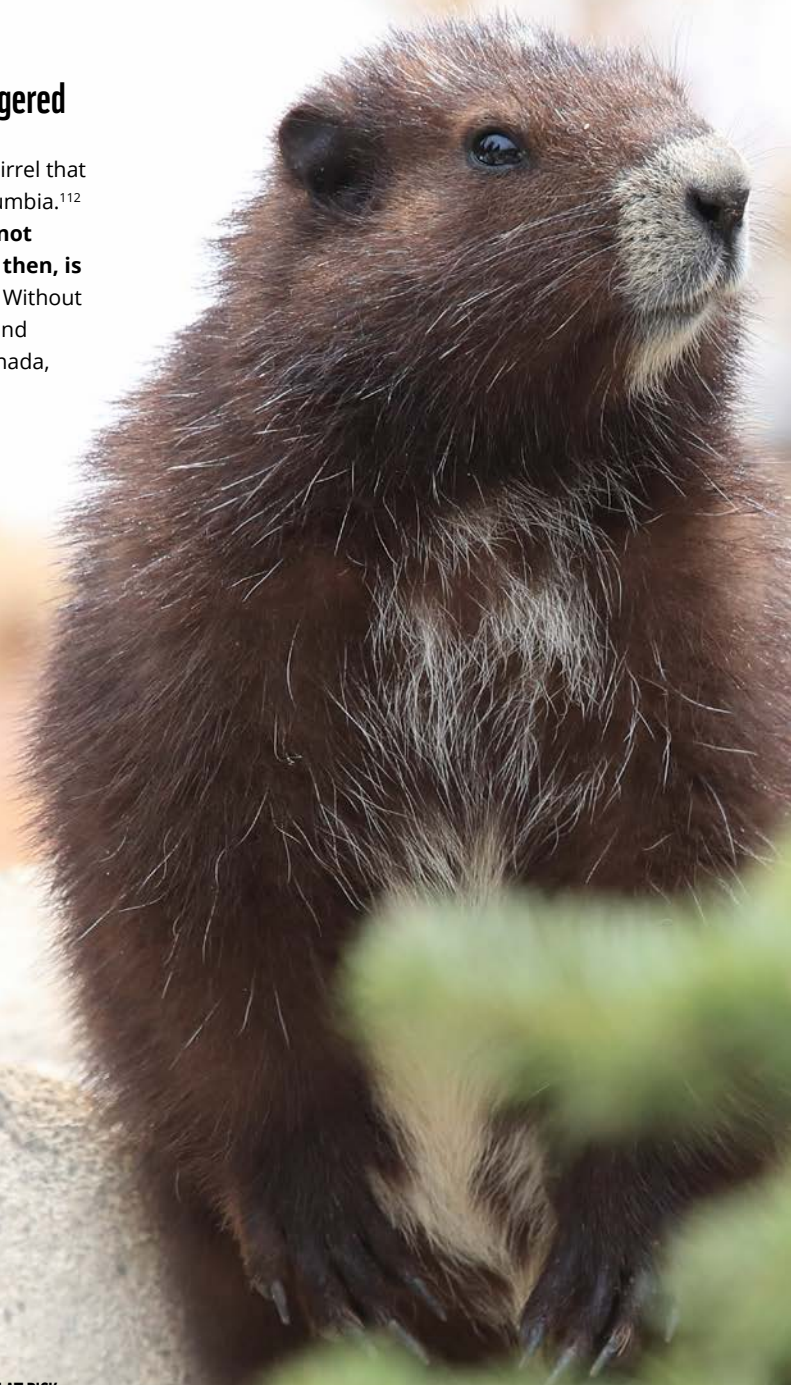
(*Marmota vancouverensis*)

COSEWIC Status: Endangered
IUCN Red List Status: Critically Endangered


The Vancouver Island marmot is a ground squirrel that is only found on Vancouver Island, British Columbia.¹¹² **It is an endemic species, which means it is not found anywhere else in the world. Canada, then, is solely responsible for ensuring its survival.** Without dedicated conservation efforts, Vancouver Island marmots might disappear — not just from Canada, but the entire planet.

Endemic species around the world are often endangered¹¹³ and protecting them is vital to conserving an ecosystem's genetic diversity.¹¹⁴ Current threats to Vancouver Island marmots, including predation and ecosystem modification, make the small population numbers and naturally restricted ranges that render the species at risk of extinction even worse.¹¹⁵

Although data are limited on historical population size, a population estimate from late 1970 estimated the population was low, at 50–100 individuals.¹¹⁶ To date, a variety of recovery actions have been undertaken to increase population abundance and achieve recovery objectives for the Vancouver Island marmot, including research and monitoring; habitat restoration, protection and stewardship; and captive breeding and reintroductions¹¹⁷ — yet the species remains vulnerable to extinction,¹¹⁸ with approximately 200 individuals in 2019.¹¹⁹



© Shutterstock



**SPECIES THAT ARE
ENDEMIC TO CANADA
ARE NOT FOUND
ANYWHERE ELSE
IN THE WORLD**

ATLANTIC PUFFIN

(*Fratercula arctica*)

COSEWIC Status: Not Assessed

IUCN Red List Status: Vulnerable

While the global population of Atlantic puffins (playfully known as “sea parrots” because of their distinct black-and-white feathers and colourful beaks) has experienced an overall decline,¹²⁰ the Canadian population has increased in abundance since 1970.¹²¹ **Canada, then, plays an important role in ensuring the persistence of the global population.**

The increase in puffins in Canada is the result of a several factors, including a reduction in bycatch due to the closure of the northern cod and Atlantic salmon gillnet fisheries in 1992.

Gillnets were known to cause seabird mortality and there were increases in puffin and other diving bird populations following the gillnet closures.¹²²

Still, puffins remain vulnerable to additional threats throughout their vast range including changes in the marine food web. Atlantic puffins are pursuit-divers, preying upon forage fish — small marine fish that are a key food source for predators and aren't faring well themselves — like herring and capelin. Puffins need lots of prey in order to breed successfully,¹²³ yet compete with fisheries for this valuable resource.¹²⁴



© Shutterstock

BARREN-GROUND CARIBOU

(*Rangifer tarandus*)

COSEWIC Status: Threatened

IUCN Red List Status: Vulnerable

BY: PAUL OKALIK, LEAD SPECIALIST, ARCTIC,
WWF-CANADA, IQALUIT



It's sad that we barely see any of the beautiful *tuktu* (barren-ground caribou) in the country where I grew up.

From the earliest days that I can

remember, I would

go out with family during our school breaks to go caribou hunting. When I was eight years old, I got my first caribou, and the custom was for the parents to host a big feast in honour of the first big animal that was caught — caribou were always a staple and staple part of our diet. It was such a joyous time.

To protect these animals, we're doing our part on the island, where harvesting is heavily regulated through community quotas. But their habitat is unprotected, and it needs to be protected so that the caribou have a place they can call home — where there's no development. It's really important that the youth learn our customs from their parents so they can continue on with our traditions, but with the heavy regulations we face, it's a challenge. The sooner we can protect their habitat, the healthier the populations will be, and I'll be able to bring my own children to enjoy the beautiful land we have and watch them harvest their own *tuktu*.

© Robert Bowhay

RECOGNIZING CONSERVATION ACTION

Across Canada, conservation actions to help wildlife have been implemented by individuals, environmental organizations, governments, industries, and Indigenous and local communities. This collective action has resulted in wildlife success stories that demonstrate the power of what can be achieved, which is encouraging as Canada works to recover additional species.

For the purpose of creating a Canadian Living Planet Index to showcase wildlife recoveries, we focused on broad-scale conservation initiatives, where targeted species and populations could be easily identified according to their taxonomy (e.g., harvest bans) or geographic location (e.g., protected areas). These conservation actions included:

Ban of persistent organic pollutants:

The Stockholm Convention on Persistent Organic Pollutants (POPs) is an international environmental treaty aimed at reducing levels of POPs in the environment by eliminating or restricting the release of specific chemicals and pesticides that accumulate in the environment and can be harmful to wildlife and humans. Canada was the first country to sign and ratify the Convention in 2004.¹²⁵



Introduction of harvest bans:

Different policies and regulations have been introduced throughout Canada to prohibit the harvest of wildlife, largely due to population declines that result from unsustainable harvesting practices. (For example, the Minister of Fisheries declared a ban on commercial whaling in Canada in 1972.¹²⁶)



North American Waterfowl Management Plan (NAWMP):

The NAWMP is an international partnership between Canada, the United States and Mexico, in which the countries work on a variety of waterfowl and habitat management issues, including conserving and restoring key waterfowl habitats across North America.¹²⁷ Since the inception of the NAWMP in 1986, over 9.2 million hectares of wetlands and associated upland habitats have been conserved in support of the NAWMP goals. This conservation action was made possible by an investment in wetland conservation of over \$2.5 billion.¹²⁸



*North American Waterfowl
Management Plan*

Protected areas:

A protected area is a clearly defined geographical space managed through legal or other effective means for the purpose of conserving biodiversity. As of 2019, 12.1 per cent of Canada's terrestrial and inland waters were conserved, including 11.4 per cent in protected areas. In addition, 13.8 per cent of marine waters were conserved, including 8.9 per cent in protected areas.¹²⁹



Captive breeding and reintroduction:

Captive breeding involves breeding rare or endangered species in captivity before reintroducing them back to their natural habitats. Successful reintroductions of species — such as for the peregrine falcon — are possible, but typically only if the threats that triggered the original decline have been removed.



Despite seemingly constant stories of dramatic wildlife declines, there have been some conservation successes at local, national and global scales. The C-LPI was used to highlight species that have been targeted through broad-scale conservation actions that have had mixed success in Canada and revealed that populations of these species have increased by 40 per cent on average from 1970 to 2016 (from 1.0 in 1970 to 1.40 in 2016; Figure 6a). This trend includes 410 population time series of 191 species, with a comparatively even distribution of taxonomic groups (Figure 6b) and trends (Figure

6c). Many factors beyond conservation action — including natural fluctuations in abundance, anthropogenic threats and natural disturbances, and the time period of management intervention — can influence the overall trend in population abundance. Consequently, while there is an association between increasing population trends and conservation action, full spectrum causation is complex. Moreover, the conservation actions themselves may be limited in practice — for example, protected areas, which are often designated based on political viability rather than prioritizing wildlife benefits.^{130 131}

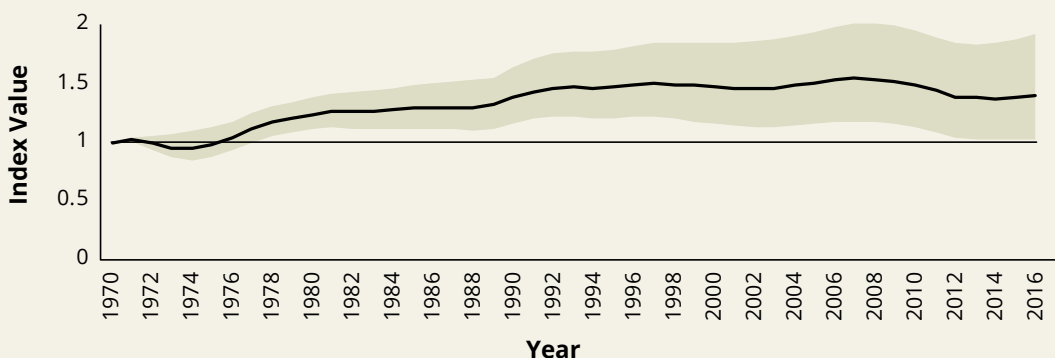


Figure 6a. The C-LPI of species that were the focus of broad-scale conservation efforts in Canada shows an average increase of 40 per cent (confidence interval range: three to 92 per cent) between 1970 and 2016. Trend in population abundance for 410 population time-series of 191 native vertebrate species.

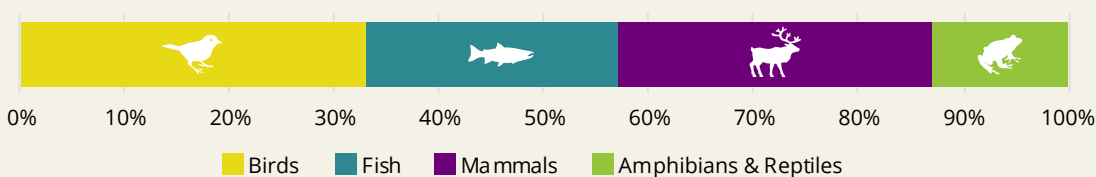


Figure 6b. Relative proportion of taxonomic groups included in the analysis (191 species).

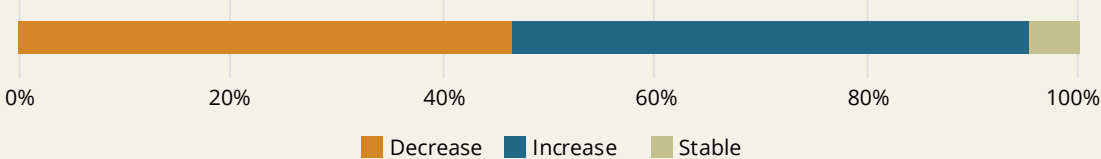


Figure 6c. Relative proportion of species with decreasing, increasing and stable trends.

TRUMPETER SWAN

(*Cygnus buccinator*)

COSEWIC Status: Not at Risk

IUCN Red List Status: Least Concern

The trumpeter swan — the largest swan in the world — occupies wetland habitats throughout North America. Trumpeter swans nest on beaver and muskrat dams and dens. In the 1600s, during the fur trade, trumpeter swans faced steep declines as beaver and muskrat populations were decimated (and therefore resulted in loss of nesting habitat for the swans).¹³² The swans were also hunted for food and their feathers, which adorned fashionable hats and were used as quills for writing.

The large wetland habitats that trumpeter swans used for migration and breeding in North America were also lost and degraded through human land use. By the early 1930s, trumpeter swans were nearly extirpated¹³³ (locally extinct) in Canada as a

result of hunting and habitat loss.¹³⁴ To reverse the loss, different conservationists and governments undertook swift and substantial conservation efforts to recover the population, including land acquisition, management plans, law enforcement, public education, and captive breeding and reintroductions to the wild. In addition, **development and implementation of the North American Waterfowl Management Plan helped to conserve and restore wetlands and other key habitats for waterfowl, including the trumpeter swan.**¹³⁵ There

are now over 70,000 trumpeter swans in North America — nearly doubling the population objectives for the

species.¹³⁶ As of 1996, the species is no

longer assessed as at risk nationally.



WHOOPING CRANE

(*Grus americana*)

COSEWIC Status: Endangered

IUCN Red List Status: Endangered

The entire naturally occurring, self-sustaining global population of whooping cranes breeds in Wood Buffalo National Park (WBNP), Canada and winters within and nearby Aransas National Wildlife Refuge (ANWR), in Texas, US. At the beginning of the 20th century, the population was reduced to just 14 individuals, mostly because of habitat loss. **Theirs is a story that shows the benefit that protected areas can have for wildlife populations.**

Whooping cranes are large waterfowl — they can reach up to 1.5 metres in height — and their habitat consists of a variety of wetlands and estuarine marshes throughout their migratory route in North America. In 1922, the WBNP park was established for the protection of wood bison, but the entire nesting grounds of the whooping crane were coincidentally included within the park's boundary, which spans 4.2 million hectares in the Northwest Territories and Alberta.¹³⁷ In 1937, the ANWR was also established as a refuge for migratory birds.¹³⁸ Since breeding and wintering whooping crane habitat were protected, the population has rebounded, particularly since the late 1980s.¹³⁹ The population now consists of 500 individuals.¹⁴⁰





© Shutterstock



SOLUTIONS THAT ADDRESS MULTIPLE THREATS

The 2019 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report revealed that an estimated one million plant and animal species around the world are now threatened with extinction.¹⁴¹

Despite conservation efforts to date, global goals and trajectories for biodiversity conservation,^{142 143} sustainable use of resources¹⁴⁴ and climate change mitigation¹⁴⁵ are unlikely to be achieved without vigorous, urgent and transformative action from all sectors of society.

Multiple threats to biodiversity — and associated ecosystem goods and services like clean water and air, which humanity relies on — are pervasive in Canada and around the world. As described in this report, simple causal threat relationships often cannot be assumed due to the many, compounding threats that species now face. Consequently, conservation actions that solely address individual threats are likely inadequate to effectively reverse biodiversity loss. We need to address a variety of biodiversity threats

such as habitat loss, overexploitation, industrial pressures and, increasingly, climate change.

Conservation strategies need to embrace systematic and multifaceted approaches — such as habitat protection and restoration — that tackle both biodiversity loss and climate change at the same time.

Until recently, species recovery, protected areas planning and climate change mitigation have been largely pursued in a disjointed manner that has not delivered the scale of impact required to effectively overcome the challenges we face. If done with multiple benefits in mind, actions to increase at-risk wildlife populations can reverse biodiversity loss and address climate change.

NATURE-BASED CLIMATE SOLUTIONS

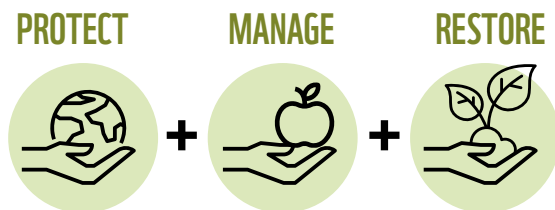
Nature-based climate solutions (NbCS) are land- and sea-based activities that support both climate change mitigation and biodiversity conservation, allowing us to address multiple threats to biodiversity at once.

Generally, NbCS aim to **protect, sustainably manage and restore** natural carbon sinks — activities that also ensure important habitat for wildlife. They're considered vital to keeping global warming below 1.5°C by avoiding conversion of natural carbon stores (i.e., through protected areas) to prevent further emissions and enhance sequestration (i.e., through restoration) to actively draw carbon out of the atmosphere. NbCS also offer a cost-effective approach to climate change mitigation (enhancing carbon storage and sequestration) and adaptation (making ecosystems more resilient to the effects of climate change),^{146 147} while also providing a broad suite of co-benefits for people and nature.¹⁴⁸ For example, nature-based climate solutions can help deal with flooding, storm surges, temperature control, carbon sequestration and human health¹⁴⁹ while

NATURAL CARBON SINKS ARE GENERALLY COMPOSED OF:

- Above-ground carbon: Landscapes with visible vegetation, such as forests, shrubs and grasses
- Below-ground carbon: Carbon stored in the soils of ecosystems, including wetlands, peatlands, boreal forests and grasslands.
- Blue carbon: Coastal habitats with vegetation, including eelgrass beds and salt marshes

also protecting and restoring important wildlife habitat. It's critical to note that although valuable, nature-based climate solutions do not decrease the urgency for rapid decarbonization of energy and industrial sectors^{150 151} — they are additive and must be implemented simultaneously.



PROTECTION AND MANAGEMENT OF HABITATS AND CARBON STORES

Collectively, five countries — including Canada — contain more than 70 per cent of the world’s remaining intact ecosystems (excluding the high seas and Antarctica). Ranking second in remaining intact ecosystems globally,¹⁵² Canada, then, has a disproportionate responsibility and opportunity to protect and sustainably manage its intact land and seascapes. Without intervention, these intact ecosystems are vulnerable to degradation and disruption from major human and industrial stressors and associated impacts such as climate change.

PROTECTED AREAS SHOULD BE ESTABLISHED AND MANAGED IN LANDS AND WATERS THAT:

- Recognize and advance Indigenous rights, knowledge systems and governance models;
- Are Key Biodiversity Areas (KBAs) or hotspots for at-risk species;
- Protect carbon stores, areas of high ecological integrity and climate refuges;
- Represent diverse ecosystems, environmental conditions and habitats;
- Are large enough to support long-term viable populations of species that are sensitive to human activities and require large areas;
- Are well managed, including through Indigenous-led or co-management, in a way that significantly reduces threats; and
- Are connected in a way that allows wildlife to move freely, recognizing potential climate change-associated range changes due to shifts in suitable habitat.

163 164 165 166 167 168 169

PROTECTED AREAS

Protected areas are a cornerstone of wildlife conservation and are increasingly referenced as nature-based climate solutions to avoid conversion or degradation of natural carbon stores. As of 2019, 12.1 per cent of Canada's terrestrial and inland waters have been conserved, including 11.4 per cent in protected areas. In addition, 13.8 per cent of marine waters have been conserved, including 8.9 per cent in protected areas.¹⁵³ Yet in Canada, surveys suggest there is public support to increase landscape protection from current values.¹⁵⁴ To that end, the government of Canada has recently expanded on current targets for protected areas — committing to 25 per cent of land and oceans protected or conserved by 2025 and 30 per cent by 2030 — which aligns with international recommendations for higher protected area targets.^{155 156}

Globally, the focus of protected areas has been quantitative — specifically, protecting 17 per cent of terrestrial and inland waters, and 10 per cent of marine areas by this year (2020). However, evidence shows that the emphasis on these area-based targets have not yet helped to achieve biodiversity goals.¹⁵⁷ In 2019, [WWF-Canada's Wildlife Protection Assessment](#) looked at the ecological representation of Canada's current protected areas network and found that the wide variety of physical habitats that wildlife need are not protected. **In fact, three quarters of physical habitats in Canada are inadequately or not at all protected.**¹⁵⁸ In addition, it appears that protected areas around the world have been established in areas that are politically viable (such as those with low agricultural value) as opposed to systematically prioritizing areas that would benefit wildlife the most.^{159 160} Percentage-based area targets are necessary and have certainly driven protected area expansion in Canada and around the world, but quantitative targets alone are insufficient to wholly conserve biodiversity.

On a global scale, Canada has a disproportionate responsibility to protect and manage its land and seascapes as it is the steward of one quarter of the world's remaining areas of high ecological integrity¹⁶¹ and therefore has the capacity to act as a conservation superpower.¹⁶² Canada's land protection targets, policies and contributions to addressing environmental crises are clearly of global significance.

To maximize the benefits of protected areas, we need an enhanced focus on the designation and management of areas of high importance for wildlife as well as carbon storage and sequestration. This ensures benefits for local communities while advancing the rights of and responsibilities to Indigenous Peoples through commitments rooted in the principles of the United Nations Declaration on the Rights of Indigenous Peoples.





**PROTECTED AREA DESIGNATION SHOULD
PRIORITIZE AREAS OF HIGH ECOLOGICAL
INTEGRITY AND LARGE CARBON STORES
TO MAXIMIZE CONSERVATION BENEFITS**

KEY BIODIVERSITY AREAS

To date, there has been little consideration for the distribution of threatened species,¹⁷⁰ important sites¹⁷¹ and abatable threats to biodiversity^{172 173} when establishing protected areas. While the amount of terrestrial and marine areas formally protected has markedly increased, there is still bias in areas that are prioritized for protection, as they are not necessarily chosen based on their effectiveness in preserving biodiversity^{174 175} or threat abatement.¹⁷⁶ Furthermore, per cent coverage of both existing and new targets for protected areas in Canada are well below the amounts that conservation science shows are needed to conserve biodiversity.¹⁷⁷ Consequently, the current protected area network is not enough to achieve our biodiversity goals¹⁷⁸ and ensure the persistence of threatened species.

There are a variety of standards, regimes and

approaches that can be used to protect biodiversity by sustainably managing and protecting areas critical to preserving wildlife. The most widely recognized of these on a global scale has been put forward by the International Union for the Conservation of Nature (IUCN) — Key Biodiversity Areas (KBAs), which are areas identified based on their contribution to safeguarding global biodiversity. The IUCN Taskforce on Biodiversity and Protected Areas assembled international governments and organizations to agree on the science-based criteria used to identify KBAs. The Global Standard for the Identification of KBAs was adopted in 2016.¹⁷⁹ All KBAs are identified using the same scientific criteria. Because KBAs are global in nature, their systematic application has the potential to address population declines of IUCN Red-Listed Threatened Species on a global scale.



To qualify as a global KBA, a site must meet at least one of 11 criteria within these five high-level categories:

- Areas where biodiversity or ecosystem types are globally threatened;
- Areas where biodiversity or ecosystem types are geographically restricted;
- Areas that are important for conserving the ecological integrity of broader systems;
- Areas that are important for biological processes; and/or
- Areas that are irreplaceable.¹⁸⁰

The new KBA Canada Coalition is in the process of applying the KBA Standard to map priority areas for conservation action in terrestrial and freshwater areas across the country. And although KBA designation does not necessarily mean that an area will receive better management or protection, it does prioritize an area for conservation action. Conservation action in these critical biodiversity

areas in Canada may include a variety of approaches, such as:

- Designating new protected areas in areas that are critical to the persistence of biodiversity;
- Altered or enhanced management of current protected areas to improve quality;
- Adoption or alteration of land-use plans and other effective area-based conservation measures (OECMs);
- Informing private sector safeguard policies, environmental standards and certification schemes; and/or
- Application of other stewardship regimes.¹⁸¹

Application of KBA standards can help to identify and subsequently protect and/or manage areas that are critical to sustaining wildlife populations, ultimately improving conservation value through enhanced quality and representativeness of Canada's protected areas network.



© Shutterstock

INDIGENOUS PROTECTED AND CONSERVED AREAS

To achieve the effective recovery and stewardship of wildlife in Canada, we need to look beyond a sole reliance on scientific knowledge systems and consider experiences and lessons from other knowledge systems. In Canada, it is critically important to learn from, rely on and embrace Indigenous knowledge systems, legal traditions and cultural practices to better conserve and maintain our land and seascapes. In fact, recent research has shown that vertebrate biodiversity on Indigenous-managed lands in Canada is slightly more species rich than in protected areas (a key conservation tool), and that Indigenous-managed lands support more threatened wildlife.¹⁸²

One effective approach is to elevate the importance, number and sovereignty of Indigenous Protected and Conserved Areas (IPCAs) in Canada. **IPCAs comprise “lands and waters where Indigenous governments have the primary role in protecting and conserving ecosystems through Indigenous laws, governance and knowledge systems.”**¹⁸³

IPCAs include a variety of land protection initiatives including Tribal Parks, Indigenous Protected Areas, Indigenous Conserved Areas and Indigenous Cultural Landscapes, some of which count towards Canada’s protected area targets. While IPCAs vary with respect to their governance approaches and management objectives, they generally have three key elements in common:¹⁸⁴

- Indigenous-led;
- Represent a long-term commitment to conservation; and
- Elevate Indigenous rights and responsibilities.

GUARDIANS

Guardians play a vital role in maintaining the ecological and cultural health of Indigenous territories, landscapes and seascapes by embracing Indigenous environmental governance. Guardians facilitate inter-generational sharing of Indigenous knowledge, steward the ecological integrity of the land, contribute to important decisions like land-use plans, provide monitoring capacity, and help to protect ecosystems and the biodiversity within them. The [Indigenous Leadership Initiative](#) is currently promoting a federally funded Indigenous-led National Indigenous Guardians Network in Canada, which supports the development and employment of Guardians in Indigenous territories. To date, over 60 Indigenous Nations and communities have begun Guardians programs in Canada.¹⁸⁵



Staffan Widstrand / WWF

INDIGENOUS-LED CONSERVATION

BY: ELI ENNS, PRESIDENT AND CEO, IISAAK OLAM FOUNDATION, TLA-O-QUI-AHT NATION CO-CHAIR, INDIGENOUS CIRCLE OF EXPERTS

I guess you could say I was born into conservation. I'm from *Nuu-Chah-nulth* on my father's side and my mother's side of the family are Dutch Mennonite immigrants. I was educated on the importance of environmental conservation from both sides and eventually moved back to my home territory and worked directly for my nation for seven years.

This was my deep education in *hishuk'ish tsawalk*, which means "everything is one and everything is connected" in *Nuu-Chah-nulth*. I eventually became one of the co-chairs of the Indigenous Circle of Experts and worked on the pathway to Target 1. Through this process, we really conceptualized Indigenous Protected and Conserved Areas (IPCAs). And this wasn't just an academic exercise to conceive of the concept — we created a movement across Canada in an all-hands-on-deck approach.

This is important because the way parks and protected areas have happened historically has been a violation of Indigenous Peoples, who were forcibly removed from their villages. The government has realized that it can't achieve its targets without consulting with Indigenous Peoples. They have to work with us.

But there's also a growing awakening to the value that Indigenous Peoples can bring to the conservation of nature through our knowledge systems. We're all going to have to work cooperatively to reach some of these targets, like protecting 25 per cent by 2025. That's more than doubling where we are now.

The way conservation in Canada has been done to date still follows a model of disconnectedness. We put a fence around nature over here, but in another part of the same watershed, we create a sacrifice zone for industry, and in yet another part, we have a community where nature is the

backdrop to people and built environments. In our approach, all of these things need to be interconnected.

That's the idea of *hishuk'ish tsawalk*. IPCAs mean that a community purposefully designs and builds within an ecosystem where the overall desired long-term outcome is to build healthy economies, communities and biodiversity.

That said, protected areas are important, but not sufficient on their own. We are pioneering a new way of thinking about nature conservation through IPCAs. It's about sound economic development and utilizing Indigenous knowledge systems and the best of western science and modern technology to design and develop comprehensive, integrated community and ecosystem health and well-being models. Imagine a constellation of IPCAs across the country. That's where we need to go.

We need a holistic approach to relationships within our territories. Five hundred years ago, on the west coast of Vancouver Island, where my father is from, we never would have needed to build tribal parks or IPCAs because of the *Nuu-Chah-nulth* understanding that everything is interconnected. We don't treat one part of our territory as more special than another. It's the idea of relationships, reciprocity and cultivating abundance for the unborn generations to come.

And this idea is key. Reconciliation may never start at the capital-city or nation-to-nation level. I think that the best place for it to take root is at the watershed level between Indigenous and non-Indigenous people who have to live with the consequences of their actions and who are committed to long-term sustainability within that particular region.



STEWARDING PROTECTED AND CONSERVED AREAS

Sufficient and sustainable management is needed for our protected areas and those with high ecological integrity to effectively protect wildlife and carbon stores across the country. Just because an area is protected (by formal or other means) does not mean that it is immune to the threat of anthropogenic degradation. For example, Wood Buffalo National Park, Canada's largest national park, which spans northeastern Alberta and the southern Northwest Territories, may soon be added to the List of World Heritage in Danger by UNESCO if adequate action is not taken to reduce current anthropogenic threats. These ongoing threats include hydroelectric dams, oilsands development, climate change, inadequate environmental monitoring and poor engagement with Indigenous communities — all of which don't bode well for the park and its wildlife.¹⁸⁶ In addition, the park lost 2,582 km² (12 per cent) of its forests from 2000 to 2012,¹⁸⁷ releasing greenhouse gases and degrading habitat quality for wildlife.

Protected area downgrading (decrease in legal restrictions), downsizing (decrease in size) and degazettement (loss of legal protection) also poses a threat to protected areas in Canada and around the world.^{188 189} For instance, the Alberta government recently announced cutting or privatizing management for over one third of sites from the Alberta Parks system. The divestment of parks puts some of these areas at risk, jeopardizing their value for conservation.¹⁹⁰ Simply put, the designation of a protected area in Canada to date does not guarantee the long-term conservation of wildlife and carbon stores — sustainable management and long-term protection are also vital components.

In addition to formal protected areas, other effective area-based conservation measures (OECMs) may help to achieve conservation goals.

These areas fall outside of the formal designation of protected areas (which have a primary conservation objective) yet are still governed and managed in ways that help to achieve positive outcomes for the conservation of biodiversity. While OECMs integrate wider landscapes and seascapes into ecologically representative and well-connected conservation systems,¹⁹¹ the accounting of OECMs towards quantitative protected and conserved areas in Canada should be reported separately¹⁹² as their conservation value and governance types differ. Nevertheless, recognition of OECMs may incentivize conservation and sustainable management of key areas that lack formal protected area designation, such as KBAs, while facilitating reconciliation and Indigenous leadership through IPCAs.¹⁹³ All of this provides people with the opportunity to steward landscapes and seascapes for long-term conservation as opposed to excluding people from nature.





**OUR EFFORTS NEED TO
SUPPORT INDIGENOUS
LEADERS AND COMMUNITIES
TO HELP ACHIEVE EQUITABLE,
EFFECTIVE AND JUST
CONSERVATION OUTCOMES**

© Shutterstock

ECOLOGICAL RESTORATION OF DEGRADED ECOSYSTEMS

Human-induced land-use change, whether it has been for food, timber or energy, has resulted in a loss of natural ecosystems and biodiversity, and has diminished Earth's ability to effectively store carbon, causing it to occasionally act as a source, rather than a sink, of GHG emissions.¹⁹⁴ Globally, 77 per cent of land (excluding Antarctica) and 87 per cent of oceans have been modified by human activity,^{195 196 197} resulting in multiple, compounding pressures for wildlife that include habitat loss, pollution and invasive species. The extent and magnitude of these changes require that degraded landscapes and seascapes are revitalized so that they provide habitat for wildlife, actively sequester carbon, and equitably deliver key goods and services for human well-being.

Broad-scale restoration has the potential to be an effective tool for addressing biodiversity loss, although it can take many decades for restoration

RESILIENT PRACTICES

Indigenous Peoples have a deep understanding of how to restore and steward ecologically diverse territories “through resilient practices” passed down through many generations.²¹⁵ This complex approach to building and securing resilient and healthy habitat for wildlife and for communities is an essential perspective on the restoration and regeneration of complex ecosystems.

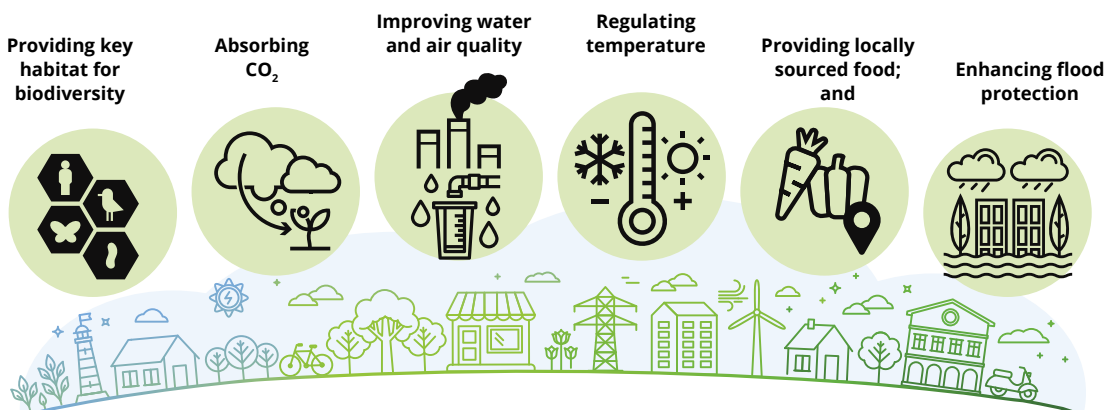
to achieve results in terms of biodiversity recovery. Increasing the area and quality of habitat that effectively supports the long-term viability of wildlife populations is vital to their recovery. Habitat restoration can provide multiple benefits beyond nature conservation, particularly

through the enhancement of ecosystem services^{198 199} (the services that nature provides to people), which relate to multiple Sustainable Development Goals.²⁰⁰ Some examples of key services provided by healthy, resilient ecosystems include cultural benefits, water purification, pollination, and climate change mitigation and adaptation. Ecological restoration serves to repair the damage that humans have done to terrestrial and coastal ecosystems



© Global Warming Images/WWF

In human-populated environments, the creation of green spaces, rooftop gardens and general expansion of vegetation cover in urbanized areas — cities, towns and villages — can be effective, for example by: ²¹⁴



and can serve as a dual solution to address both biodiversity loss and climate change by enhancing natural carbon sequestration and storage potential through the creation and enhancement of healthy ecosystems.^{201 202}

In Canada, forests, wetlands, grasslands, built-up regions where human populations are high, and coastal ecosystems could all benefit from large-scale restoration — particularly in southern Canada where human footprint is high.²⁰³ Globally, Canada has among the lowest levels of connectivity between its protected areas,²⁰⁴ so restoring connectivity between isolated patches of habitat will also be needed to ensure that wildlife can move freely between protected land and seascapes. Targeting restoration activities at ecosystems with greater potential benefits can enhance conservation gains while reducing costs.²⁰⁵ However, strategies

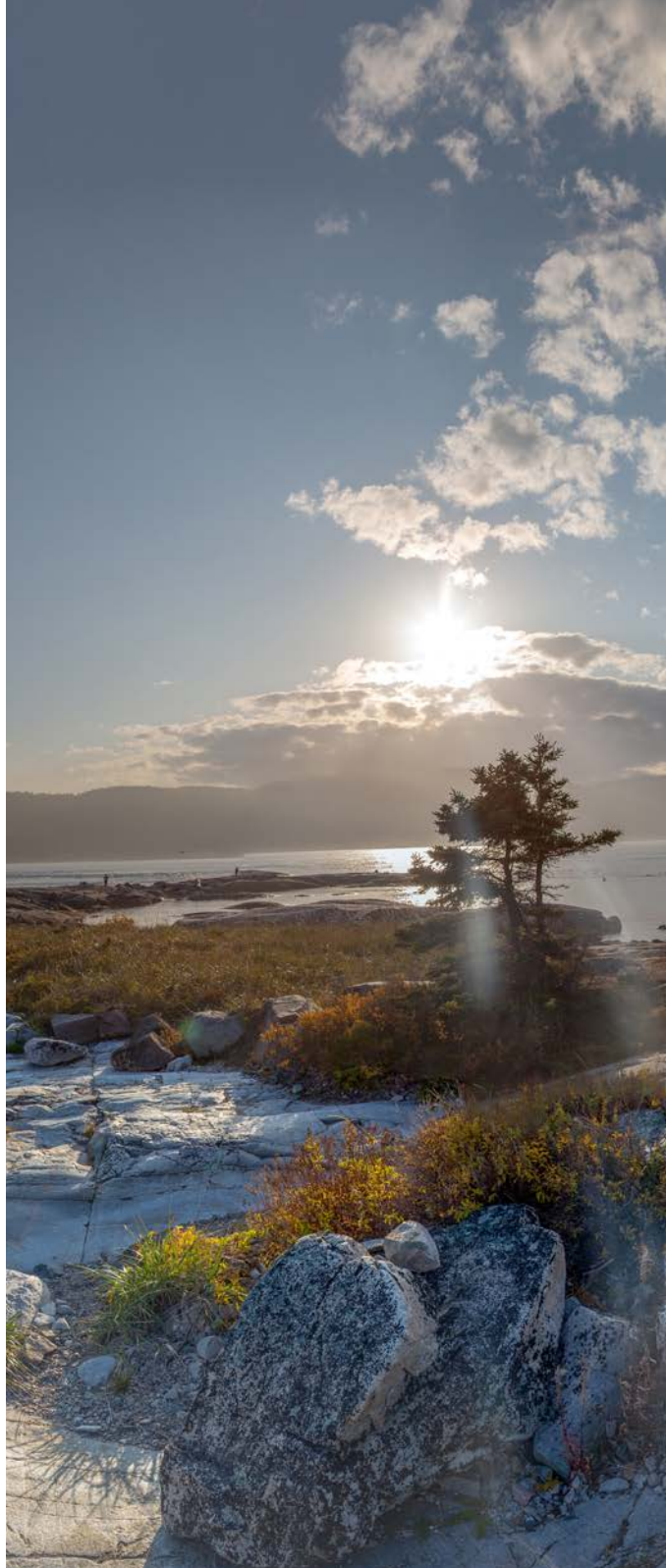
and goals should be adapted to local ecological and socioeconomic environments to optimize their success.²⁰⁶ The recent Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report states that rapid ecological restoration of native species can offset environmental degradation and consequently recover at-risk species. In addition to the benefits to biodiversity, restoration initiatives are expected to have co-benefits for local communities.²⁰⁷

While small-scale restoration initiatives have been implemented for centuries, collaborative large-scale restoration is needed to repair the world’s extensive human-modified land and seascapes. Canada currently ranks among the top 20 countries with the highest land-based GHG mitigation potential — largely attributed to enhanced sustainable management and restoration of forests

and agricultural areas.²⁰⁸ Large-scale habitat restoration, particularly of forests, grasslands and marine coastal ecosystems, can create conditions for natural carbon sequestration, while providing habitat for wildlife. If left undisturbed — through formal protection or strict management — restored habitats can retain stored carbon over the long term.

For example, coastal ecosystems such as salt marshes and seagrass meadows are important marine habitats and can act as long-term carbon sinks. Plants and algae in the marine environment take up carbon dioxide from the atmosphere or the ocean and incorporate it into their biomass (termed “blue carbon”). Over time, as some of that biomass dies, it becomes buried in marine sediments, where it can be sequestered long term. Salt marshes and seagrass beds are particularly effective at trapping and storing carbon and can do so at rates that are much higher than terrestrial forests.²⁰⁹ These coastal marine ecosystems also act as important habitats for wildlife such as fish, invertebrates and birds, and provide valuable ecosystem services such as storm protection and nutrient retention. However, shoreline development, eutrophication, climate change and disruptions to food webs from overharvesting are all threats to these ecosystems^{210 211} that can result in decreased carbon storage as well as increased carbon emissions.²¹² Protecting and restoring these blue carbon ecosystems is essential for providing viable habitat for marine life and storing carbon to support climate change mitigation.

To underscore the biodiversity and climate benefits of ecological restoration, the United Nations General Assembly has proclaimed the upcoming decade (2021–2030) as the Decade on Ecosystem Restoration. The UN Decade on Ecosystem Restoration reinforces that preventing, halting and reversing the degradation of ecosystems around the world is fundamental to achieving numerous Sustainable Development Goals, and can be done in a relatively cost-effective manner.²¹³





© Shutterstock

MOVING FORWARD

The findings of WWF-Canada's Living Planet Report Canada 2020 show that immediate action is needed to safeguard Canada's imperiled wildlife — those species of national and international conservation concern. In our study, COSEWIC-assessed and IUCN Red-Listed species in Canada have experienced continued declines in their populations from 1970–2016. We also found that COSEWIC-assessed at-risk species are impacted by multiple, simultaneous threats — five, on average — including the growing threat of climate change. To make progress, we urgently need to implement conservation strategies that address multiple threats to biodiversity, including a changing climate.

The successful recovery of wildlife depends on effectively mitigating or reversing the stressors that are driving population declines in the first place. In order to address the cumulative impacts of anthropogenic threats that are driving wildlife declines in Canada — particularly for at-risk species — current conservation strategies must be enhanced, and efforts should be focused on solutions that address multiple threats simultaneously and can be applied at broad scales.

In the last two years, we have seen important commitments from the Government of Canada toward new conservation goals and programs, including for the recovery of at-risk species, expansion of our protected areas network, and reducing greenhouse gas emissions consistent with a 1.5°C future. To be successful, these initiatives need to be deeply integrated to maximize their benefits for wildlife, climate and people.

Indigenous-led conservation is one of the greatest

transformative drivers toward effectively renewing our relationships with nature. Indigenous knowledge and leadership are critical for effective and equitable conservation outcomes. Conservation efforts in Canada will increasingly need to support and embrace leadership, management and guidance from First Nation, Métis and Inuit communities.

Nature-based climate solutions provide a framework to integrate the recovery of wildlife in Canada, reducing multiple threats to at-risk species, while also working to limit climate change and build future ecosystem resilience. They also create an opportunity to apply long-held Indigenous knowledge to enrich and sustain wildlife populations.

Protected areas that effectively limit the conversion and degradation of important habitats for wildlife and key areas of stored carbon can be an effective mechanism to stop wildlife loss and fight climate



change. In addition, broad-scale restoration of degraded ecosystems is crucial to building back important habitats for the recovery of at-risk species and the active sequestration of carbon from the atmosphere.

We are at a pivotal moment for conservation in Canada and around the world. In the coming months, Canada will help set a new global biodiversity framework as part of the Convention on Biological Diversity. This process provides a critical opportunity to develop and implement an ambitious international plan to safeguard biodiversity with targets and tools that provide co-benefits to society.

In this urgent moment, **Canada has an important opportunity to provide global leadership** — not only to demonstrate much-needed ambition, but also to show the world how new, integrative approaches to wildlife recovery and climate change mitigation can

be achieved through nature-based climate solutions and Indigenous-led conservation. This includes effective protected areas planning and management targeted to prevent the further loss of key habitats for wildlife populations and conversion of important carbon storage areas. This should happen alongside broad-scale restoration of degraded ecosystems for the recovery of species at risk and active sequestration of carbon from the atmosphere. These actions need to be guided by Indigenous knowledge and scientific knowledge, with each applied where appropriate to deliver the greatest overall positive impact for wildlife, climate and people.

It is not a small task, but it is our shared responsibility to take the necessary actions to reverse the trends of wildlife loss in Canada.

REFERENCES

- 1 CESSC. 2016. Wild species 2015: The general status of species in Canada. *Canadian Endangered Species Conservation Council: National General Status Working Group*. Canada. www.wildspecies.ca.
- 2 Allan JR. Venter O. Watson JEM. 2017. Temporally inter-comparable maps of terrestrial wilderness and the Last of the Wild. *Scientific Data*. 4: 170187. DOI: [10.1038/sdata.2017.187](https://doi.org/10.1038/sdata.2017.187).
- 3 Riggio J. Baillie JEM. Brumby S. Ellis E. Kennedy CM. Oakleaf JR. *et al.* 2020. Global human influence maps reveal clear opportunities in conserving Earth's remaining intact terrestrial ecosystems. *Global Change Biology*. DOI: [10.1111/gcb.15109](https://doi.org/10.1111/gcb.15109).
- 4 Watson JEM. Venter O. Lee J. Jones KR. Robinson JG. Possingham HP. *et al.* 2018. Protect the last of the wild. *Nature*. 563: 27-30. DOI: [10.1038/d41586-018-07183-6](https://doi.org/10.1038/d41586-018-07183-6).
- 5 ECCC. 2020. National Inventory Report 1990-2018: Greenhouse gas sources and sinks in Canada – Canada's submission to the United Nations Framework Convention on Climate Change. *Environment and Climate Change Canada*. Gatineau, Quebec. <https://unfccc.int>.
- 6 WWF and ZSL. 2018. Living planet index. *World Wildlife Fund and Zoological Society of London*. Gland, Switzerland. <http://www.livingplanetindex.org/home/index>.
- 7 WWF. 2018. Living planet report – 2018: Aiming higher. Grooten M. Almond REA. *World Wildlife Fund*. Gland, Switzerland. <https://wwf.panda.org>.
- 8 WWF-Canada, ZSL and GFN. Canadian living planet report 2007. *World Wildlife Fund Canada, Zoological Society of London and Global Footprint Network*. Toronto, Canada. <http://assets.wwf.ca>.
- 9 WWF-Canada. 2017. Living planet report Canada: A national look at wildlife loss. Currie J. Giles E. Snider J. *World Wildlife Fund Canada*. Toronto, Canada. DOI: [10.13140/RG.2.2.24442.34247](https://doi.org/10.13140/RG.2.2.24442.34247).
- 10 ECCC. 2018. Canadian Environmental Sustainability Indicators: Canadian species index. *Environment and Climate Change Canada*. Gatineau, Quebec. www.canada.ca.
- 11 NABCI-Canada. 2019. The State of Canada's Birds, 2019. *North American Bird Conservation Initiative Canada, Environment and Climate Change Canada*. Ottawa, Canada. www.stateofcanadasbirds.org.
- 12 Collen B. Loh J. Whitmee S. McRae L. Amin R. Baillie JEM. 2009. Monitoring change in vertebrate abundance: the Living Planet Index. *Conservation Biology*. 23(2): 317-327. DOI: [10.1111/j.1523-1739.2008.01117.x](https://doi.org/10.1111/j.1523-1739.2008.01117.x).
- 13 WWF-Canada. 2017. Living planet report Canada: A national look at wildlife loss. Currie J. Giles E. Snider J. *World Wildlife Fund Canada*. Toronto, Canada. DOI: [10.13140/RG.2.2.24442.34247](https://doi.org/10.13140/RG.2.2.24442.34247).
- 14 ECCC. 2018. Canadian Environmental Sustainability Indicators: Canadian species index. *Environment and Climate Change Canada*. Gatineau, Quebec. www.canada.ca.
- 15 Marconi V. McRae L. Muller H. Currie J. Whitmee S. Gadallach F. *et al.* 2020. Coverage of a national biodiversity indicator: data of different quality show diverging trends. *In review*.
- 16 CESSC. 2016. Wild species 2015: The general status of species in Canada. *Canadian Endangered Species Conservation Council: National General Status Working Group*. Canada. www.wildspecies.ca.
- 17 Marconi V. McRae L. Muller H. Currie J. Whitmee S. Gadallach F. *et al.* 2020. Coverage of a national biodiversity indicator: data of different quality show diverging trends. *In review*.
- 18 ICE. 2018. We rise together: Achieving Pathway to Canada Target 1 through the creation of Indigenous Protected and Conserved Areas in the spirit and practice of reconciliation. Enns E. Littlechild D. *Indigenous Circle of Experts*. Canada. <https://www.conservation2020canada.ca/resources>.
- 19 CESSC. 2016. Wild species 2015: The general status of species in Canada. *Canadian Endangered Species Conservation Council: National General Status Working Group*. Canada. www.wildspecies.ca.

- 20 Di Marco M. Chapman S. Althor G. Kearney S. Besancon C. Butt N. *et al.* 2017. Changing trends and persisting biases in three decades of conservation science. *Global Ecology and Conservation*. 10: 32-42. DOI: [10.1016/j.gecoo.2017.01.008](https://doi.org/10.1016/j.gecoo.2017.01.008).
- 21 CESSC. 2016. Wild species 2015: The general status of species in Canada. *Canadian Endangered Species Conservation Council: National General Status Working Group*. Canada. www.wildspecies.ca.
- 22 COSEWIC. 2015. COSEWIC assessment and status report on the Shortnose sturgeon *Acipenser brevirostrum* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://wildlife-species.canada.ca>.
- 23 DFO. 2016. Management plan for the shortnose sturgeon (*Acipenser brevirostrum*) in Canada. Species at Risk Act Management Plan Series. *Fisheries and Oceans Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 24 COSEWIC. 2015. COSEWIC assessment and status report on the Shortnose sturgeon *Acipenser brevirostrum* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://wildlife-species.canada.ca>.
- 25 COSEWIC. 2017. COSEWIC assessment and status report on the Peregrine Falcon *Falco peregrinus* (pealei subspecies – *Falco peregrinus pealei* and *anatum/tundrius* – *Falco peregrinus anatum/tundrius*) in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 26 Environment Canada. 2005. Part 1: Canada's National Implementation Plan (NIP) under the Stockholm Convention on Persistent Organic Pollutants. *Environment Canada*. Gatineau, Quebec. <http://ec.gc.ca/>.
- 27 COSEWIC. 2017. COSEWIC assessment and status report on the Peregrine Falcon *Falco peregrinus* (pealei subspecies – *Falco peregrinus pealei* and *anatum/tundrius* – *Falco peregrinus anatum/tundrius*) in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 28 COSEWIC. 2017. COSEWIC assessment and status report on the Peregrine Falcon *Falco peregrinus* (pealei subspecies – *Falco peregrinus pealei* and *anatum/tundrius* – *Falco peregrinus anatum/tundrius*) in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 29 COSEWIC. 2014. COSEWIC assessment and status report on the Wolverine *Gulo gulo* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.sararegistry.gc.ca>.
- 30 COSEWIC. 2014. COSEWIC assessment and status report on the Wolverine *Gulo gulo* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.sararegistry.gc.ca>.
- 31 NABCI-Canada. 2019. The State of Canada's Birds, 2019. *North American Bird Conservation Initiative Canada, Environment and Climate Change Canada*. Ottawa, Canada. www.stateofcanadasbirds.org.
- 32 COSEWIC. 2011. COSEWIC assessment and status report on the humpback whale *Megaptera novaeangliae* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.sararegistry.gc.ca>.
- 33 COSEWIC. 2011. COSEWIC assessment and status report on the humpback whale *Megaptera novaeangliae* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.sararegistry.gc.ca>.
- 34 Pauly D. 1995. Anecdotes and shifting baseline syndrome of fisheries. *Trends in Ecology and Evolution*. 10(10): 430. DOI: [10.1016/s0169-5347\(00\)89171-5](https://doi.org/10.1016/s0169-5347(00)89171-5).
- 35 COSEWIC. 2009. COSEWIC assessment and status report on the Swift Fox *Vulpes velox* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 36 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S. Settele J. Brondizio E. Ngo HT. Guèze M. Agard J. *et al.* *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat*. Bonn, Germany. <https://ipbes.net/global-assessment>.

- 37 WWF-Canada. 2017. Living planet report Canada: A national look at wildlife loss. Currie J. Giles E. Snider J. *World Wildlife Fund Canada*. Toronto, Canada. DOI: [10.13140/RG.2.2.24442.34247](https://doi.org/10.13140/RG.2.2.24442.34247).
- 38 COSEWIC. n.d. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <http://cosewic.ca>.
- 39 Government of Canada. 2019. Species listing process: Species at Risk Act. *Government of Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 40 Government of Canada. 2019. Species at risk public registry. *Government of Canada*. Ottawa, Ontario. <https://species-registry.canada.ca>.
- 41 Creighton MJA, Bennett JR. 2019. Taxonomic biases persist from listing to management for Canadian species at risk. *Écoscience*. DOI: [10.1080/11956860.2019.1613752](https://doi.org/10.1080/11956860.2019.1613752).
- 42 Dirzo R, Young HS, Galetti M, Ceballos G, Isaac NJB, Collen B. 2014. Defaunation in the Anthropocene. *Science*. 345(6195): 401-406. DOI: [10.1126/science.1251817](https://doi.org/10.1126/science.1251817).
- 43 Butchart SHM, Walpole M, Collen B, van Strien A, Scharlemann JP Almond REA, et al. 2010. Global biodiversity: Indicators of recent declines. *Science*. 328: 1164-1168. DOI: [10.1126/science.1187512](https://doi.org/10.1126/science.1187512).
- 44 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S, Settele J, Brondizio E, Ngo HT, Guèze M, Agard J, et al. *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat*. Bonn, Germany. <https://ipbes.net/global-assessment>.
- 45 Salafsky N, Salzer D, Stattersfield AJ, Hilton-Taylor C, Neugarten R, Butchart SHM, et al. 2008. A standard lexicon for biodiversity conservation: Unified classifications of threats and actions. *Conservation Biology*. 22(4): 897-911. DOI: [10.1111/j.1523-1739.2008.00937](https://doi.org/10.1111/j.1523-1739.2008.00937).
- 46 McCune JL, Colla SR, Coristine LE, Davy CM, Flockhart DDT, Schuster R, et al. 2019. Are we accurately estimating the potential role of pollution in the decline of species at risk in Canada. *FACETS*. 4: 598-614. DOI: [10.1139/facets-2019-0025](https://doi.org/10.1139/facets-2019-0025).
- 47 Currie J, Marconi V. 2020. An analysis of threat and factors that predict trends in Canadian vertebrates designated as at-risk. *FACETS*. 5: 49-66. DOI: [10.1139/facets-2019-0017](https://doi.org/10.1139/facets-2019-0017).
- 48 Dirzo R, Young HS, Galetti M, Ceballos G, Isaac NJB, Collen B. 2014. Defaunation in the Anthropocene. *Science*. 345(6195): 401-406. DOI: [10.1126/science.1251817](https://doi.org/10.1126/science.1251817).
- 49 COSEWIC. 2012. COSEWIC assessment and status report on the Western Tiger Salamander *Ambystoma mavortium* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.sararegistry.gc.ca>.
- 50 Brook BW, Sodhi NS, Bradshaw JA. 2008. Synergies among extinction drivers under global change. *Trends in Ecology and Evolution*. 23(8): 453-460. DOI: [10.1016/j.tree.2008.03.011](https://doi.org/10.1016/j.tree.2008.03.011).
- 51 COSEWIC. 2018. COSEWIC assessment and status report on the Wood Turtle *Glyptemys insculpta* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 52 Erb L, Jones MT. 2011. Can turtle mortality be reduced in managed fields? *Northeastern Naturalist*. 18(4):489-496. DOI: [10.1656/045.018.0406](https://doi.org/10.1656/045.018.0406).
- 53 COSEWIC. 2018. COSEWIC assessment and status report on the Wood Turtle *Glyptemys insculpta* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 54 Currie J, Marconi V. 2020. An analysis of threats and factors that predict trends in Canadian vertebrates designated as at-risk. *FACETS*. 5: 49-66. DOI: [10.1139/facets-2019-0017](https://doi.org/10.1139/facets-2019-0017).
- 55 Maxwell SL, Fuller RA, Brooks TM, Watson JEM. 2016. The ravages of guns, nets and bulldozers. *Nature*. 536: 143-145. DOI: [10.1038/536143a](https://doi.org/10.1038/536143a).
- 56 Mooers AØ, Prugh LR, Festa-Bianchet M, Hutchings JA. 2007. Biases in legal listing under Canadian Endangered species legislation. *Conservation Biology*. 21(3): 572-575. DOI: [10.1111/j.1523-1739.2007.00689.x](https://doi.org/10.1111/j.1523-1739.2007.00689.x).
- 57 Findlay CS, Elgie S, Giles B, Burr L. 2009. Species listing under Canada's Species at Risk Act. *Conservation Biology*. 23(6): 1609-1617. DOI: [10.1111/j.1523-1739.2009.01255.x](https://doi.org/10.1111/j.1523-1739.2009.01255.x).
- 58 Creighton MJA, Bennett JR. 2019. Taxonomic biases persist from listing to management for Canadian species at risk. *Écoscience*. DOI: [10.1080/11956860.2019.1613752](https://doi.org/10.1080/11956860.2019.1613752).

- 59 Creighton MJA, Bennett JR. 2019. Taxonomic biases persist from listing to management for Canadian species at risk. *Écoscience*. DOI: [10.1080/11956860.2019.1613752](https://doi.org/10.1080/11956860.2019.1613752).
- 60 COSEWIC. 2012. COSEWIC assessment and status report on the Leatherback Sea Turtle *Dermochelys coriacea* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 61 DFO. 2012. Assessment of leatherback turtle (*Dermochelys coriacea*) fishery and non-fishery interactions in Atlantic Canadian waters. *Fisheries and Oceans Canada*. Canadian Science Advisory Secretariat Science Response. 2012/041. <https://waves-vagues.dfo-mpo.gc.ca>.
- 62 COSEWIC. 2012. COSEWIC assessment and status report on the Leatherback Sea Turtle *Dermochelys coriacea* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 63 DFO. 2018. Action plan for the leatherback sea turtle (*Dermochelys coriacea*) in Atlantic Canada [proposed]. Species at Risk Act Action Plan Series. *Fisheries and Oceans Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 64 COSEWIC. 2012. COSEWIC assessment and status report on the Leatherback Sea Turtle *Dermochelys coriacea* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 65 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S, Settele J, Brondizio E, Ngo HT, Guèze M, Agard J, et al. *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat*. Bonn, Germany. <https://ipbes.net/global-assessment>.
- 66 Currie J, Marconi V. 2020. An analysis of threat and factors that predict trends in Canadian vertebrates designated as at-risk. *FACETS*. 5: 49-66. DOI: [10.1139/facets-2019-0017](https://doi.org/10.1139/facets-2019-0017).
- 67 IPCC. 2018. Global warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development and efforts to eradicate poverty. Masson-Delmotte V, Zhai P, Pörtner HO, Roberts D, Skea J, Shukla PR, et al. *Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/sr15/>.
- 68 ECCC. 2020. National Inventory Report 1990-2018: Greenhouse gas sources and sinks in Canada – Canada’s submission to the United Nations Framework Convention on Climate Change. *Environment and Climate Change Canada*. Gatineau, Quebec. <https://unfccc.int>.
- 69 Bush E, Lemmen DS. 2019. Canada’s changing climate report. *Government of Canada*. Ottawa, Ontario. <https://www.nrcan.gc.ca>.
- 70 IPCC. 2018. Global warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development and efforts to eradicate poverty. Masson-Delmotte V, Zhai P, Pörtner HO, Roberts D, Skea J, Shukla PR. *Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/sr15/>.
- 71 COSEWIC. 2011. COSEWIC assessment and status report on the collared pika *Ochotona collaris* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.registrelep-sararegistry.gc.ca>.
- 72 Millar JS, Zwickel FC. 1972. Characteristics and ecological significance of hay piles of pikas. *Mammalia*. 36(4): 657-667. DOI: [10.1515/mamm.1972.36.4.657](https://doi.org/10.1515/mamm.1972.36.4.657).
- 73 Morrison SF, Pelchat G, Donahue DA, Hik DS. 2009. Influence of food hoarding behavior on the over-winter survival of pikas in strongly seasonal environments. *Oecologia*. 159:107-116. DOI: [10.1007/s00442-008-1197-5](https://doi.org/10.1007/s00442-008-1197-5).
- 74 COSEWIC. 2011. COSEWIC assessment and status report on the collared pika *Ochotona collaris* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.registrelep-sararegistry.gc.ca>.

- 75 COSEWIC. 2011. COSEWIC assessment and status report on the collared pika *Ochotona collaris* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.registrelep-sararegistry.gc.ca>.
- 76 COSEWIC. 2017. COSEWIC assessment and status report on the Atlantic walrus *Odobenus rosmarus rosmarus*, high Arctic population, central-low Arctic population and Nova Scotia-Newfoundland-Gulf of St. Lawrence population in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca/>.
- 77 COSEWIC. 2017. COSEWIC assessment and status report on the Atlantic walrus *Odobenus rosmarus rosmarus*, high Arctic population, central-low Arctic population and Nova Scotia-Newfoundland-Gulf of St. Lawrence population in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca/>.
- 78 Bailey AW. McCartney D. Schellenberg MP. 2010. Management of Canadian prairie rangeland. *Agriculture and Agri-Food Canada*. Canada. 10144: 1-58. <http://publications.gc.ca>.
- 79 EC. 1991. The federal policy on wetland conservation. Minister of Supply and Services. *Environment Canada*. Ottawa, Ontario. <http://publications.gc.ca>.
- 80 Wang J. 2018. Canada's statistics on land cover and land use change in metropolitan areas. Prepared for the 16th Conference of the International Association of Official Statisticians (IAOS) OECD Headquarters. *Statistics Canada*. <http://www.oecd.org>.
- 81 Sykes L. Santini L. Etard A. Newbold T. 2019. Effects of rarity on species' responses to land use. *Conservation Biology*. 34(3) 688-696. DOI: 10.1111/cobi.13419.
- 82 Gibson SY. Van der Marel RC. Starzomski BM. 2009. Climate change and conservation of leading edge peripheral populations. *Conservation Biology*. 23(6): 1369-1373. DOI: 10.1111/j.1523-1739.2009.01375.x.
- 83 Coristine LE. Jacob AL. Schuster R. Otto SP. Baron NE. Bennett NJ. *et al.* 2018. Informing Canada's commitment to biodiversity conservation: a sciences-based framework to help guide protected areas designation through Target 1 and beyond. *FACETS*. 3: 531-562. DOI: 10.1139/facets-2017-0102.
- 84 WWF-Canada. 2019. Wildlife protection assessment: A national habitat crisis. Arabian J. Currie J. Snider J. *World Wildlife Fund Canada*. Toronto, Canada. DOI: 10.13140/RG.2.2.22764.62089.
- 85 Venter O. Sanderson EW. Magrath A. Allan JR. Behr J. Jones KR. *et al.* 2016. Sixteen years of change in the global terrestrial human footprint and implications for biodiversity conservation. *Nature Communications*. 7: 12558. DOI: 10.1038/ncomms12558.
- 86 Tilman D. Clark M. Williams DR. Kimmel K. Polasky S. Packer C. 2017. Future threats to biodiversity and pathways to their prevention. *Nature*. 546: 73-81. DOI: 10.1038/nature22900.
- 87 Di Marco M. Venter O. Possingham HP. Watson JEM. 2018. Changes in human footprint drive changes in species extinction risk. *Nature Communications*. 9: 4621. DOI: 10.1038/s41467-018-07049-5.
- 88 IPCC. 2019. Climate change and land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Arneth A. Barbosa H. Benton T. Calvin K. Calvo E. Connors S. *et al.* *Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/srccl/>.
- 89 Chen I-C. Hill JK. Ohlemüller R. Roy DB. Thomas CD. 2011. Rapid range shifts of species associated with high levels of climate warming. *Science*. 333 (6045): 1024-1026. DOI: 10.1126/science.1206432.
- 90 IPCC. 2019. Climate change and land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Arneth A. Barbosa H. Benton T. Calvin K. Calvo E. Connors S. *et al.* *Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/srccl/>.
- 91 IPCC. 2019. Climate change and land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Arneth A. Barbosa H. Benton T. Calvin K. Calvo E. Connors S. *et al.* *Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/srccl/>.

- 92 Scobie CA. Bayne EM. Wellicome TI. 2019. Evaluating cropland in the Canadian prairies as an ecological trap for the endangered burrowing owl *Athene cunicularia*. *Ibis*. 162: 162-174. DOI: [10.1111/ibi.12711](https://doi.org/10.1111/ibi.12711).
- 93 COSEWIC. 2017. COSEWIC assessment and status report on the Burrowing Owl *Athene cunicularia* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 94 COSEWIC. 2017. COSEWIC assessment and status report on the Burrowing Owl *Athene cunicularia* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 95 COSEWIC. 2017. COSEWIC assessment and status report on the Burrowing Owl *Athene cunicularia* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 96 IPCC. 2019. The ocean and cryosphere in a changing climate. An IPCC Special Report. Pörtner H-O. Roberts DC. Masson-Delmotte V. Zhai P. Tignor M. Poloczanska E. *et al.* *Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/srocc/>.
- 97 Mcleod E. Chmura GL. Bouillon S. Salm R. Björk M. Duarte CM. *et al.* 2011. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO₂. *Frontiers in Ecology and the Environment*. 9(10): 552-560. DOI: [10.1890/110004](https://doi.org/10.1890/110004).
- 98 IPCC. 2019. The ocean and cryosphere in a changing climate. An IPCC Special Report. Pörtner H-O. Roberts DC. Masson-Delmotte V. Zhai P. Tignor M. Poloczanska E. *et al.* *Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/srocc/>.
- 99 Record NR. Runge JA. Pendleton DE. Balch WM. Davies TA. Pershing AJ. *et al.* 2019. Rapid climate-driven circulation changes threaten conservation of endangered North Atlantic right whales. *Oceanography Society*. 32(2): 162-169. DOI: [10.5670/oceanog.2019.201](https://doi.org/10.5670/oceanog.2019.201).
- 100 COSEWIC. 2013. COSEWIC assessment and status report on the North Atlantic Right Whale *Eubalaena glacialis* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 101 Meyer-Gutbrod EL. Greene CH. Davies KTA. 2018. Marine species range shifts necessitate advanced policy planning: the case of the North Atlantic right whale. *Oceanography*. 31(2): 19-23. DOI: [10.5670/oceanog.2018.209](https://doi.org/10.5670/oceanog.2018.209).
- 102 DFO. 2018. Science advice on timing of the mandatory slow-down zone for shipping traffic in the Gulf of St. Lawrence to protect the North Atlantic right whale. *Fisheries and Oceans Canada*. Canadian Science Advisory Secretariat Science Response. 2017/042. <https://waves-vagues.dfo-mpo.gc.ca>.
- 103 Daoust P-Y. Couture ÉL. Wimmer T. Bourque L. 2017. Incident report: North Atlantic right whale mortality event in the Gulf of St. Lawrence, 2017. *Canadian Wildlife Health Cooperative, Marine Animal Response Society, Fisheries and Oceans Canada*. Charlottetown, Prince Edward Island. <http://www.cwhc-rcsf.ca/>.
- 104 DFO. 2019. Fishing closures for North Atlantic right whale protection. *Fisheries and Oceans Canada*. Ottawa, Ontario. <https://www.dfo-mpo.gc.ca>.
- 105 Transport Canada. 2019. Protecting North Atlantic right whales from collisions with ships in the Gulf of St. Lawrence. *Transport Canada*. Ottawa, Ontario. <https://www.tc.gc.ca>.
- 106 Oceana Canada. Right of way – Slow down ships to protect right whales. *Oceana Canada*. Toronto, Ontario. <https://oceana.ca>.
- 107 COSEWIC. 2013. COSEWIC assessment and status report on the North Atlantic Right Whale *Eubalaena glacialis* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 108 DFO. 2019. North Atlantic right whale. *Fisheries and Oceans Canada*. Ottawa, Ontario. <https://www.dfo-mpo.gc.ca/>.
- 109 IUCN. 2020. The IUCN Red List of Threatened Species. *International Union for Conservation of Nature*. Gland, Switzerland. <https://www.iucnredlist.org/>.
- 110 Gunn A. 2016. *Rangifer tarandus* – The IUCN Red List of Threatened Species 2016: e. T29742A22167140. *International Union for Conservation of Nature*. Gland, Switzerland. <https://www.iucnredlist.org>.

- 111 Watson JEM, Venter O, Lee J, Jones KR, Robinson JG, Possingham HP. *et al.* 2018. Protect the last of the wild. *Nature*. 563: 27-30. DOI: [10.1038/d41586-018-07183-6](https://doi.org/10.1038/d41586-018-07183-6).
- 112 COSEWIC. 2019. COSEWIC assessment and status report on the Vancouver Island Marmot *Marmota vancouverensis* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 113 Işık K. 2010. Rare and endemic species: Why are they prone to extinction? *Turkish Journal of Botany*. 35(4): 411-417. DOI: [10.3906/bot-1012-90](https://doi.org/10.3906/bot-1012-90).
- 114 Gorman CE, Potts BM, Schweitzer JA, Bailey JK. 2014. Shifts in species interactions due to the evolution of functional differences between endemics and non-endemics: An endemic syndrome hypothesis. *PLoS ONE*. 9(10): e111190. DOI: [10.1371/journal.pone.0111190](https://doi.org/10.1371/journal.pone.0111190).
- 115 COSEWIC. 2019. COSEWIC assessment and status report on the Vancouver Island Marmot *Marmota vancouverensis* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 116 Jackson C, Baker A, Doyle D, Franke M, Jackson V, Lloyd N. *et al.* 2015. Vancouver Island marmot population and habitat viability assessment workshop final report. *IUCN SSC Conservation Breeding Specialist Group*. Apple Valley, Minnesota. <https://portals.iucn.org/>.
- 117 Vancouver Island Marmot Recovery Team. 2017. Recovery plan for the Vancouver Island Marmot (*Marmota vancouverensis*) in British Columbia. Prepared for the B.C. Ministry of Environment. Victoria, British Columbia. <http://a100.gov.bc.ca>.
- 118 COSEWIC. 2019. COSEWIC assessment and status report on the Vancouver Island Marmot *Marmota vancouverensis* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 119 Marmot Recovery Foundation. 2019. Final report 2019. *Marmot Recovery Foundation*. Nanaimo, British Columbia. <https://marmots.org>.
- 120 BirdLife International. 2018. *Fratercula arctica*. *The IUCN Red List of Threatened Species* 2018: e.T22694927A132581443. <https://www.iucnredlist.org>.
- 121 ECCC. 2019. The status of birds in Canada website, data-version 2019. *Environment and Climate Change Canada*. Gatineau, Quebec. <https://wildlife-species.canada.ca>.
- 122 Regular P, Montevocchi W, Hedd A, Robertson G, Wilhelm S. 2013. Canadian fishery closures provide a large-scale test of the impact of gillnet bycatch on seabird populations. *Biology Letters*. 9: 20130088. DOI: [10.1098/rsbl.2013.0088](https://doi.org/10.1098/rsbl.2013.0088).
- 123 Cury PM, Boyd IL, Bonhommeau S, Anker-Nilssen T, Crawford RJM, Furness RW. *et al.* 2011. Global seabird response to forage fish depletion – one-third for the birds. *Science*. 334 (6063): 1703-1706. DOI: [10.1126/science.1212928](https://doi.org/10.1126/science.1212928).
- 124 Grémillet D, Ponchon A, Paleczny M, Palomares M-LD, Karpouzi V, Pauly D. 2018. Persisting worldwide seabird-fishery competition despite seabird community decline. *Current Biology*. 28(24): 4009-4013. DOI: [10.1016/j.cub.2018.10.051](https://doi.org/10.1016/j.cub.2018.10.051).
- 125 ECCC. 2018. Stockholm Convention of Persistent Organic Pollutants. *Environment and Climate Change Canada*. Gatineau, Quebec. <https://www.canada.ca>.
- 126 Mercer MC. 1980. Canadian delegation report - 32nd Annual Meeting International Whaling Commission. *Fisheries and Oceans*. Ottawa, Ontario. <https://waves-vagues.dfo-mpo.gc.ca>.
- 127 NAWMP. 2013. What is NAWMP. *North American Waterfowl Management Plan | Canada*. Gatineau, Quebec. <http://nawmp.wetlandnetwork.ca>.
- 128 ECCC. 2019. The Government of Canada invests to protect wetlands and migratory birds. News release. *Environment and Climate Change Canada*. Gatineau, Quebec. <https://www.canada.ca>.
- 129 ECCC. 2020. Canadian Protected and Conserved Areas Database. *Environment and Climate Change Canada*. Gatineau, Quebec. <https://www.canada.ca>.
- 130 Venter O, Magrach A, Outram N, Klein CJ, Possingham HP, Di Marco M. *et al.* 2017. Bias in protected-area location and its effects on long-term aspirations of biodiversity conventions. *Conservation Biology*. 32(1): 127-134. DOI: [10.1111/cobi.12970](https://doi.org/10.1111/cobi.12970).
- 131 Stevenson SL, Woolley SNC, Barnett J, Dunstan P. 2019. Testing the presence of marine protected areas against their ability to reduce pressures on biodiversity. *Conservation Biology*. DOI: [10.1111/cobi.13429](https://doi.org/10.1111/cobi.13429).
- 132 Banko WE. 1960. The trumpeter swan: its history, habits, and population in the United States. *North American Fauna*. 63: 1-214. <https://pubs.er.usgs.gov>.

- 133 US FWS and EC. 1986. North American Waterfowl Management Plan. *United States Fish and Wildlife Service and Environment Canada*. <http://nawmp.wetlandnetwork.ca>.
- 134 ECCC. 2015. Trumpeter swan (*Cygnus buccinator*). *Environment and Climate Change Canada*. Gatineau, Quebec. <https://wildlife-species.canada.ca>.
- 135 US FWS and EC. 1986. North American Waterfowl Management Plan. *United States Fish and Wildlife Service and Environment Canada*. <http://nawmp.wetlandnetwork.ca>.
- 136 NAWMP. 2018. 2018 North American Waterfowl Management Plan (NAWMP) update: Connecting people, waterfowl, and wetlands. *North American Waterfowl Management Plan*. <https://nawmp.org/>.
- 137 COSEWIC. 2010. COSEWIC assessment and status report on the Whooping Crane *Grus Americana* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 138 US FWS. 2013. Aransas National Wildlife Refuge – Texas: About the refuge. *United States Fish and Wildlife Service*. Washington, District of Columbia. <https://www.fws.gov/>.
- 139 COSEWIC. 2010. COSEWIC assessment and status report on the Whooping Crane *Grus Americana* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. Ottawa, Ontario. <https://www.canada.ca>.
- 140 Butler MJ, Harrell W. 2019. Whooping crane survey results: winter 2018-2019. *United States Fish and Wildlife Service*. Washington, District of Columbia. <https://www.fws.gov>.
- 141 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S. Settele J. Brondizio E. Ngo HT. Guèze M. Agard J. *et al. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat*. Bonn, Germany. <https://ipbes.net/global-assessment>.
- 142 Ceballos G. Ehrlich PR. Raven PH. 2020. Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction. *Proceedings of the National Academy of Sciences of the United States of America*. DOI: [10.1073/pnas.1922686117](https://doi.org/10.1073/pnas.1922686117).
- 143 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S. Settele J. Brondizio E. Ngo HT. Guèze M. Agard J. *et al. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat*. Bonn, Germany. <https://ipbes.net/global-assessment>.
- 144 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S. Settele J. Brondizio E. Ngo HT. Guèze M. Agard J. *et al. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat*. Bonn, Germany. <https://ipbes.net/global-assessment>.
- 145 CBD. 2011. Strategic plan for biodiversity 2011-2020, including Aichi biodiversity targets. *Convention on Biological Diversity*. Montreal, Quebec. <https://www.cbd.int/sp/>.
- IPCC. 2018. Global warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development and efforts to eradicate poverty. Masson-Delmotte V. Zhai P. Pörtner HO. Roberts D. Skea J. Shukla PR. *et al. Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/sr15/>.
- 146 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S. Settele J. Brondizio E. Ngo HT. Guèze M. Agard J. *et al. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat*. Bonn, Germany. <https://ipbes.net/global-assessment>.
- 147 Seddon N. Chausson A. Berry P. Girardin CAJ. Smith A. Turner B. 2020. Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B*. 375: 20190120. DOI: [10.1098/rstb.2019.0120](https://doi.org/10.1098/rstb.2019.0120).

- 148 Seddon N. Chausson A. Berry P. Girardin CAJ. Smith A. Turner B. 2020. Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B*. 375: 20190120. DOI: [10.1098/rstb.2019.0120](https://doi.org/10.1098/rstb.2019.0120).
- 149 Seddon N. Chausson A. Berry P. Girardin CAJ. Smith A. Turner B. 2020. Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B*. 375: 20190120. DOI: [10.1098/rstb.2019.0120](https://doi.org/10.1098/rstb.2019.0120).
- 150 Anderson CM. DeFries RS. Litterman R. Matson PA. Nepstad DC. Pacala S. *et al.* 2019. Natural climate solutions are not enough. *Science*. 363(6430): 933-934. DOI: [10.1126/science.aaw2741](https://doi.org/10.1126/science.aaw2741).
- 151 Seddon N. Chausson A. Berry P. Girardin CAJ. Smith A. Turner B. 2020. Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B*. 375: 20190120. DOI: [10.1098/rstb.2019.0120](https://doi.org/10.1098/rstb.2019.0120).
- 152 Watson JE. Venter O. Lee J. Jones KR. Robinson JG. Possingham HP. Allan JR. 2018. Protect the last of the wild. *Nature*. 563: 27-30. DOI: [10.1038/d41586-018-07183-6](https://doi.org/10.1038/d41586-018-07183-6).
- 153 ECCC. 2020. Canadian Protected and Conserved Areas Database. *Environment and Climate Change Canada*. Gatineau, Quebec. <https://www.canada.ca>.
- 154 Earnscliffe Strategy Group. 2017. National conservation survey. *Earnscliffe Strategy Group*. Canada. <https://earnsccliffe.ca>.
- 155 Dinerstein E. Wynne C. Sala E. Joshi AR. Fernando. Lovejoy TE. *et al.* 2019. A global deal for nature: Guiding principles, milestones and targets. *Science Advances*. 5(4): eaaw2869. DOI: [10.1126/sciadv.aaw2869](https://doi.org/10.1126/sciadv.aaw2869).
- 156 Roberts CM. O'Leary BC. Hawkins JP. 2020. Climate change mitigation and nature conservation both require higher protected area targets. *Philosophical Transactions of the Royal Society B*. 375: 20190121. DOI: [10.1098/rstb.2019.0121](https://doi.org/10.1098/rstb.2019.0121).
- 157 Visconti P. Butchart SHM. Brooks TM. Langhammer PF. Marnewick D. Vergara S. *et al.* 2019. Protected area targets post-2020. *Science*. 364 (6437): 239-241. DOI: [10.1126/science.aav6886](https://doi.org/10.1126/science.aav6886).
- 158 WWF-Canada. 2019. Wildlife protection assessment: A national habitat crisis. Arabian J. Currie J. Snider J. *World Wildlife Fund Canada*. Toronto, Canada. DOI: [10.13140/RG.2.2.22764.62089](https://doi.org/10.13140/RG.2.2.22764.62089).
- 159 Venter O. Magrach A. Outram N. Klein CJ. Possingham HP. Di Marco M. *et al.* 2017. Bias in protected-area location and its effects on long-term aspirations of biodiversity conventions. *Conservation Biology*. 32(1): 127-134. DOI: [10.1111/cobi.12970](https://doi.org/10.1111/cobi.12970).
- 160 Stevenson SL. Woolley SNC. Barnett J. Dunstan P. 2019. Testing the presence of marine protected areas against their ability to reduce pressures on biodiversity. *Conservation Biology*. DOI: [10.1111/cobi.13429](https://doi.org/10.1111/cobi.13429).
- 161 Allan JR. Venter O. Watson JEM. 2017. Temporally inter-comparable maps of terrestrial wilderness and the Last of the Wild. *Scientific Data*. 4: 170187. DOI: [10.1038/sdata.2017.187](https://doi.org/10.1038/sdata.2017.187).
- 162 Coristine LE Colla S. Bennett N. Carlsson AM. Davy C. Davies KTA. *et al.* 2019. National contributions to global ecosystem values. *Conservation Biology*. 33(5): 1219-1223. DOI: [10.1111/cobi.13284](https://doi.org/10.1111/cobi.13284).
- 163 Watson JE. Venter O. Lee J. Jones KR. Robinson JG. Possingham HP. *et al.* 2018. Protect the last of the wild. *Nature*. 563: 27-30. DOI: [10.1038/d41586-018-07183-6](https://doi.org/10.1038/d41586-018-07183-6).
- 164 Venter O. Fuller RA. Segan DB. Carwardine J. Brooks T. Butchart SHM. *et al.* Targeting global protected area expansion for imperiled biodiversity. *PLoS Biology*. 12(6): e1001891. DOI: [10.1371/journal.pbio.1001891](https://doi.org/10.1371/journal.pbio.1001891).
- 165 WWF-Canada. 2019. Wildlife protection assessment: A national habitat crisis. Arabian J. Currie J. Snider J. *World Wildlife Fund Canada*. Toronto, Canada. DOI: [10.13140/RG.2.2.22764.62089](https://doi.org/10.13140/RG.2.2.22764.62089).
- 166 Coristine LE. Jacob AI. Schuster R. Otto SP. Baron NE. Bennett NJ. *et al.* 2018. Informing Canada's commitment to biodiversity conservation: A science-based framework to help guide protected areas designation through Target 1 and beyond. *FACETS*. 3: 531-562. DOI: [10.1139/facets-2017-0102](https://doi.org/10.1139/facets-2017-0102).
- 167 Geldmann J. Manica A. Burgess ND. Coad L. Balmford A. 2019. A global-level assessment of the effectiveness of protected areas at resisting anthropogenic pressures. *Proceedings of the National Academy of Sciences of the United States of America*. DOI: [10.1073/pnas.1908221116](https://doi.org/10.1073/pnas.1908221116).

- 168 Jones KR, Watson JEM, Possingham HP, Klein CJ. 2016. Incorporating climate change into spatial conservation prioritization: a review. *Biological Conservation*. 194: 121-130. DOI: [10.1016/j.biocon.2015.12.008](https://doi.org/10.1016/j.biocon.2015.12.008).
- 169 Hanson JO, Rhodes JR, Butchart SHM, Buchanan GM, Rondinini C, Ficetola GF, *et al.* 2020. Global conservation of species' niches. *Nature*. 580: 232-234. DOI: [10.1038/s41586-020-2138-7](https://doi.org/10.1038/s41586-020-2138-7).
- 170 Venter O, Fuller RA, Segan DB, Carwardine J, Brooks T, Butchart SHM, *et al.* 2014. Targeting global protected area expansion for imperiled biodiversity. *PLoS Biology*. 12(6): e1001891. DOI: [10.1371/journal.pbio.1001891](https://doi.org/10.1371/journal.pbio.1001891).
- 171 Butchart SHM, Scharlemann JPW, Evans MI, Quader S, Aricò S, Arinaitwe J, *et al.* 2014. Protecting important sites for biodiversity contributes to meeting global conservation targets. *PLoS ONE*. 7(3): e32529. DOI: [10.1371/journal.pone.0032529](https://doi.org/10.1371/journal.pone.0032529).
- 172 Stevenson SL, Woolley SNC, Barnett J, Dunstan P. 2019. Testing the presence of marine protected areas against their ability to reduce pressures on biodiversity. *Conservation Biology*. DOI: [10.1111/cobi.13429](https://doi.org/10.1111/cobi.13429).
- 173 Kuempel CD, Jones KR, Watson JEM, Possingham HP. 2019. Quantifying biases in marine-protected-area placement relative to abatable threats. *Conservation Biology*. 33(6): 1350-1359. DOI: [10.1111/cobi.13340](https://doi.org/10.1111/cobi.13340).
- 174 Venter O, Magrach A, Outram N, Klein CJ, Possingham HP, Di Marco M *et al.* 2017. Bias in protected-area location and its effects on long-term aspirations of biodiversity conventions. *Conservation Biology*. 32(1): 127-134. DOI: [10.1111/cobi.12970](https://doi.org/10.1111/cobi.12970).
- 175 Stevenson SL, Woolley SNC, Barnett J, Dunstan P. 2019. Testing the presence of marine protected areas against their ability to reduce pressures on biodiversity. *Conservation Biology*. DOI: [10.1111/cobi.13429](https://doi.org/10.1111/cobi.13429).
- 176 Kuempel CD, Jones KR, Watson JEM, Possingham HP. 2019. Quantifying biases in marine-protected-area placement relative to abatable threats. *Conservation Biology*. 33(6): 1350-1359. DOI: [10.1111/cobi.13340](https://doi.org/10.1111/cobi.13340).
- 177 Woodley S, Bhola N, Maney C, Locke H. 2019. Area-based conservation beyond 2020: A global survey of conservation scientists. *The International Journal of Protected Areas and Conservation*. 25(2): 19-30. DOI: [10.2305/IUCN.CH.2019.PARKS-25-2SW1.en](https://doi.org/10.2305/IUCN.CH.2019.PARKS-25-2SW1.en).
- 178 Watson JEM, Dudley N, Segan DB, Hockings M. 2014. The performance and potential of protected areas. *Nature*. 515: 67-73. DOI: [10.1038/nature13947](https://doi.org/10.1038/nature13947).
- 179 IUCN. 2016. A global standard for the identification of Key Biodiversity Areas, version 1.0. First edition. *International Union for Conservation of Nature*. Gland, Switzerland. <https://portals.iucn.org/>.
- 180 IUCN. 2016. A global standard for the identification of Key Biodiversity Areas, version 1.0. First edition. *International Union for Conservation of Nature*. Gland, Switzerland. <https://portals.iucn.org/>.
- 181 KBA Canada. 2019. Next steps. *Key Biodiversity Areas Canada*. <http://www.kbacanada.org/>.
- 182 Schuster R, Germain RR, Bennett JR, Reo NJ, Arcese P. 2019. Vertebrate biodiversity on indigenous-managed lands in Australia, Brazil and Canada equals that in protected areas. *Environmental Science and Policy*. 101: 1-6. DOI: [10.1016/j.envsci.2019.07.002](https://doi.org/10.1016/j.envsci.2019.07.002).
- 183 ICE. 2018. We rise together: Achieving Pathway to Canada Target 1 through the creation of Indigenous Protected and Conserved Areas in the spirit and practice of reconciliation. Enns E, Littlechild D. *Indigenous Circle of Experts*. Canada. <https://www.conservation2020canada.ca/resources>.
- 184 ICE. 2018. We rise together: Achieving Pathway to Canada Target 1 through the creation of Indigenous Protected and Conserved Areas in the spirit and practice of reconciliation. Enns E, Littlechild D. *Indigenous Circle of Experts*. Canada. <https://www.conservation2020canada.ca/resources>.
- 185 ILI. 2020. Backgrounder: Indigenous-led conservation - creating jobs and economic opportunity. Indigenous Leadership Initiative. Canada. <https://www.ilinationhood.ca/2020/07/06/indigenous-led-conservation-creating-jobs-economic-opportunity/>.

- 186 UNESCO. 2019. World Heritage Committee – Forty-third session. *United Nations Educational, Scientific and Cultural Organization*. Paris, France. <http://whc.unesco.org>.
- 187 Allan JR. Venter O. Maxwell S. Bertzky B. Jones K. Shi Y. *et al.* 2017. Recent increases in human pressure and forest lost threaten many Natural World Heritage Sites. *Biological Conservation*. 206: 47-55. DOI: [10.1016/j.biocon.2016.12.011](https://doi.org/10.1016/j.biocon.2016.12.011).
- 188 Mascia MB. Pailler S. 2011. Protected area downgrading, downsizing, and degazettement (PADDD) and its conservation implications. *Conservation Letters*. 4: 9-20. DOI: [10.1111/j.1755-263X.2010.00147.x](https://doi.org/10.1111/j.1755-263X.2010.00147.x).
- 189 UNEP-WCMC and IUCN. 2019. Protected planet: The world database on protected areas (WDPA). *United Nations Environment Programme World Conservation Monitoring Centre and International Union for Conservation of Nature*. Cambridge, United Kingdom. <https://www.paddtracker.org/>
- 190 Alberta Government. 2020. Optimizing Alberta parks. *Alberta Government*. Edmonton, Alberta. <https://www.alberta.ca>.
- 191 IUCN. 2019. Recognizing and reporting other effective area-based conservation measures. *IUCN-WCPA Task Force on OECMs*. Gland, Switzerland. <https://portals.iucn.org>.
- 192 CBD. 2019. Report of the thematic workshop on area-based conservation measures for the post-2020 global biodiversity framework. *Convention on Biological Diversity*. La Prairie, Quebec. <https://www.cbd.int>.
- 193 IUCN. 2019. Recognizing and reporting other effective area-based conservation measures. *IUCN-WCPA Task Force on OECMs*. Gland, Switzerland. <https://portals.iucn.org>.
- 194 IPCC. 2019. Climate change and land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Arneth A. Barbosa H. Benton T. Calvin K. Calvo E. Connors S. *et al.* *Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/srccl/>.
- 195 Watson JE. Venter O. Lee J. Jones KR. Robinson JG. Possingham HP. *et al.* 2018. Protect the last of the wild. *Nature*. 563: 27-30. DOI: [10.1038/d41586-018-07183-6](https://doi.org/10.1038/d41586-018-07183-6).
- 196 Allan JR. Venter O. Watson JEM. 2017. Temporally inter-comparable maps of terrestrial wilderness and the Last of the Wild. *Scientific Data*. 4: 170187. DOI: [10.1038/sdata.2017.187](https://doi.org/10.1038/sdata.2017.187).
- 197 Jones KR. Klein CJ. Halpern BS. Venter O. Grantham H. Kuempel CD. *et al.* 2018. The location and protection status of Earth's diminishing marine wilderness. *Current Biology*. 28(15): 2506-2512. DOI: [10.1016/j.cub.2018.06.010](https://doi.org/10.1016/j.cub.2018.06.010).
- 198 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S. Settele J. Brondizio E. Ngo HT. Guèze M. Agard J. *et al.* *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat*. Bonn, Germany. <https://ipbes.net/global-assessment>.
- 199 IPCC. 2019. Climate change and land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Arneth A. Barbosa H. Benton T. Calvin K. Calvo E. Connors S. *et al.* *Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/srccl/>
- 200 UN. 2015. Sustainable Development Goals. *United Nations*. New York, New York. <https://www.un.org>.
- 201 Seddon N. Chausson A. Berry P. Girardin CAJ. Smith A. Turner B. 2020. Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B*. 375: 20190120. DOI: [10.1098/rstb.2019.0120](https://doi.org/10.1098/rstb.2019.0120).
- 202 IPCC. 2019. Climate change and land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Arneth A. Barbosa H. Benton T. Calvin K. Calvo E. Connors S. *et al.* *Intergovernmental Panel on Climate Change*. Geneva, Switzerland. <https://www.ipcc.ch/srccl/>.
- 203 Venter O. Sanderson EW. Magrath A. Allan JR. Behr J. Jones KR. 2016. Sixteen years of change in the global terrestrial human footprint and implications for biodiversity conservation. *Nature Communications*. 7: 12558 DOI: [10.1038/ncomms12558](https://doi.org/10.1038/ncomms12558).

- 204 Saura S. Bertzky B. Bastin L. Battistella L. Mandrici A. Dubois G. 2018. Protected area connectivity: Shortfalls in global targets and country-level priorities. *Biological Conservation*. 219: 53-67. DOI: [10.1016/j.biocon.2017.12.020](https://doi.org/10.1016/j.biocon.2017.12.020).
- 205 Strassburg BBN. Beyer HL. Crouzeilles R. Iribarrem A. Barros F. de Siqueira MF. *et al.* 2019. Strategic approaches to restoring ecosystems can triple conservation gains and halve costs. *Nature Ecology and Evolution*. 3: 62-70. DOI: [10.1038/s41559-018-0743-8](https://doi.org/10.1038/s41559-018-0743-8).
- 206 Jones HP. Jones PC. Barbier EB. Blackburn RC. Benayas JMR. Holl KD. *et al.* 2018. Restoration and repair of Earth's damaged ecosystems. *Proceedings of the Royal Society B: Biological Sciences*. 285: 20172577. DOI: [10.1098/rspb.2017.2577](https://doi.org/10.1098/rspb.2017.2577).
- 207 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S. Settele J. Brondizio E. Ngo HT. Guèze M. Agard J. *et al.* *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat*. Bonn, Germany. <https://ipbes.net/global-assessment>.
- 208 Roe S. Streck C. Obersteiner M. Frank S. Griscom B. Drouet L. *et al.* 2019. Contribution of the land sector to a 1.5°C world. *Nature Climate Change*. 9: 817-828. DOI: [10.1038/s41558-019-0591-9](https://doi.org/10.1038/s41558-019-0591-9).
- 209 Mcleod E. Chmura GL. Bouillon S. Salm R. Björk M. Duarte CM *et al.* 2011. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO₂. *Frontiers in Ecology and the Environment*. 9(10): 552-560. DOI: [10.1890/110004](https://doi.org/10.1890/110004).
- 210 CEC. 2016. North America's Blue Carbon: Assessing seagrass, salt marsh and mangrove distribution and carbon sinks. *Commission for Environmental Cooperation*. Montreal, Canada. <http://www3.cec.org/>.
- 211 Atwood TB. Connolly RM. Ritchie EG. Lovelock CE. Heithaus, MR. Hays GC. *et al.* 2015. Predators help protect carbon stocks in blue carbon ecosystems. *Nature Climate Change*. 5(12): 1038-1045. DOI: [10.1038/nclimate2763](https://doi.org/10.1038/nclimate2763).
- 212 Duarte CM. Losada IJ. Hendriks IE. Mazarrasa I. Marbà N. 2013. The role of coastal plant communities for climate change mitigation and adaptation. *Nature Climate Change*. 3(11): 961-968. DOI: [10.1038/nclimate1970](https://doi.org/10.1038/nclimate1970).
- 213 UNEP and FAO. 2019. The UN Decade on Ecosystem Restoration 2021-2030. *United Nations Environment Programme and Food and Agriculture Organization of the United Nations*. <https://www.decadeonrestoration.org/>.
- 214 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S. Settele J. Brondizio E. Ngo HT. Guèze M. Agard J. *et al.* *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat*. Bonn, Germany. <https://ipbes.net/global-assessment>.
- 215 Ignance MB. Ignance RE. Turner NJ. 2016. Re tmicw te skukwstéls es tuwitentels: Secwepemc Traditional Ecological Knowledge and Wisdom Now and in the Future. Secwepemc people and plants: Research papers in Shuswap ethnobotany. *Contributions in Ethnobiology*. 407-440.



A Canada with abundant
wildlife, where nature and
people thrive.

wwf.ca

Living Planet Report Canada is generously supported by the



Patrick and Barbara
Keenan Foundation