

Boreal Birds Need Half:

*Maintaining North America's Bird Nursery
and Why It Matters*



BOREAL SONGBIRD INITIATIVE

www.borealbirds.org


DUCKS
UNLIMITED

TABLE OF CONTENTS

3 SECTION 1: MAINTAINING NORTH AMERICA'S BIRD NURSERY

- 4 Introduction
- 7 North America's Bird Nursery
- 10 Birds and the Aboriginal Way of Life
- 13 Leading the Way: A Balanced Approach to the Future of the Boreal Forest Region
- 14 Recommendations for Maintaining North America's Bird Nursery

15 SECTION 2: A SNAPSHOT OF THE CANADIAN BOREAL FOREST REGION

- 17 Yukon
- 17 British Columbia
- 17 Northwest Territories
- 18 Alberta
- 18 Saskatchewan
- 19 Manitoba
- 19 Ontario
- 20 Quebec
- 21 Newfoundland and Labrador

22 SECTION 3: WHY BOREAL BIRDS MATTER

- 24 Economic Drivers
- 24 Plant Pollinators
- 25 Seed Dispersal
- 25 Nutrient Redistributors
- 26 Pest Control
- 26 Environmental Indicators

27 LITERATURE CITED

AUTHORS

Jeff Wells, Ph.D.

Science and Policy Director, Boreal Songbird Initiative

David Childs

Communications and Policy Specialist, Boreal Songbird Initiative

Frederic Reid, Ph.D.

Director of Boreal and Arctic Conservation, Ducks Unlimited Inc.

Kevin Smith

National Manager, Boreal Programs, Ducks Unlimited Canada

Marcel Darveau, Ph.D.

Head, Boreal Research and Conservation, Quebec, Ducks Unlimited Canada

Valerie Courtois

*Director, Aboriginal Leadership Initiative,
International Boreal Conservation Campaign*

ABOUT THE BOREAL SONGBIRD INITIATIVE

The Boreal Songbird Initiative (BSI) is a non-profit organization dedicated to outreach and education about the importance of the boreal forest region to North America's birds, other wildlife, and the global environment.

ABOUT DUCKS UNLIMITED INC.

Ducks Unlimited Inc. (DU) is the world's largest non-profit organization dedicated to conserving North America's continually disappearing waterfowl habitats. Established in 1937, Ducks Unlimited has conserved more than 13 million acres thanks to contributions from more than a million supporters across the continent. Guided by science and dedicated to program efficiency, DU works toward the vision of wetlands sufficient to fill the skies with waterfowl today, tomorrow and forever.

ABOUT DUCKS UNLIMITED CANADA

Ducks Unlimited Canada (DUC) is the leader in wetland conservation. A registered charity, DUC partners with government, industry, non-profit organizations and landowners to conserve wetlands that are critical to waterfowl, wildlife and the environment.

SUGGESTED CITATION

Wells, J., D. Childs, F. Reid, K. Smith, M. Darveau, and V. Courtois. 2014. Boreal Birds Need Half: Maintaining North America's Bird Nursery and Why it Matters. Boreal Songbird Initiative, Seattle, Washington, Ducks Unlimited Inc., Memphis, Tennessee, and Ducks Unlimited Canada, Stonewall, Manitoba.

CREDITS

Cover photos: Lesser Scaup © Glen Tepke; Palm Warbler, Short-billed Dowitcher, and Bay-breasted Warbler © Jeff Nadler; Aerial forest image © D. Langhorst

All maps produced by Ducks Unlimited Canada.

Graphic design by Lisa Holmes, Yulan Studio.

All content copyright © 2014 Boreal Songbird Initiative, Ducks Unlimited Inc., and Ducks Unlimited Canada.

Maintaining North America's Bird Nursery



INTRODUCTION

The North American boreal forest, encompassing 1.5 billion acres from Alaska to Newfoundland, is one of the largest ecologically intact regions on Earth.

© Jeff Nadler



The Ruby-crowned Kinglet is one of more than 300 species that rely on the boreal forest.

THE IMPORTANCE OF THE NORTH AMERICAN BOREAL FOREST FOR BIRDS

- *More than 300 bird species rely on the boreal forest for nesting or migratory stopover habitat, nearly half of the species that frequent Canada and the United States.*
- *1-3 billion individual birds flock to the North American boreal forest each spring to find habitat for summer breeding.*
- *After the young have hatched, 3-5 billion birds migrate back out of the boreal each fall toward wintering habitat as near as the lower 48 United States and as far as the southern tip of South America.*
- *Certain types of birds are heavily reliant on the boreal forest for breeding, including 80% of North America's waterfowl species, 63% of finch species, and 53% of warbler species.*

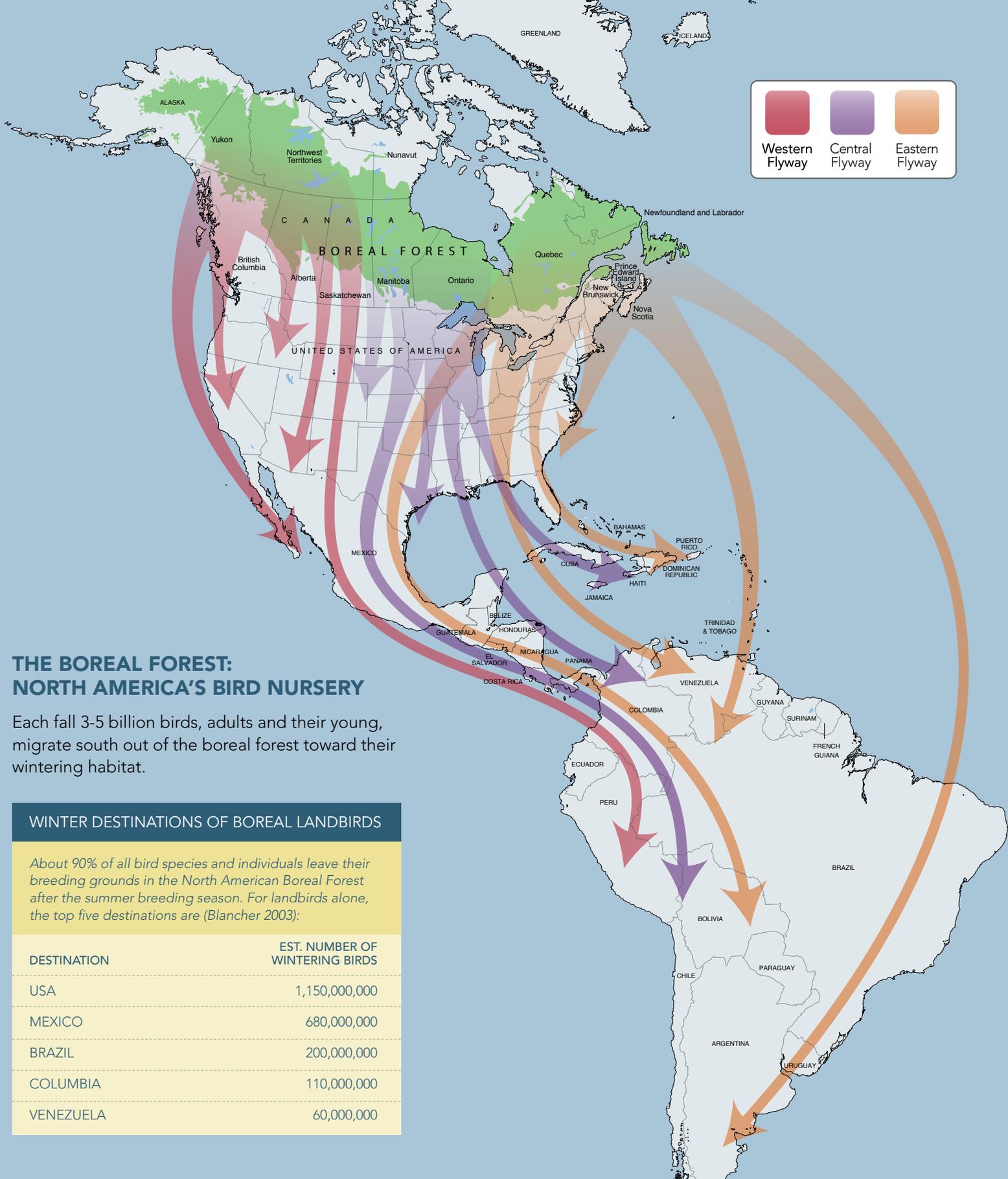
Approximately 1.2 billion acres of the forest is still nearly pristine, free of industrial development. (Blancher and Wells 2005, Wells 2011, Lee et al. 2006). The vast boreal forest includes a surprising variety of habitats and landforms: thick coniferous forests, glacier-capped mountains, sprawling peatlands, and some of the world's largest lakes, rivers, and networks of wetlands.

Because of the size, variety, and intactness of the North American boreal forest, it teems with wildlife, including an estimated 1-3 billion nesting birds each summer, earning it the title of "North America's bird nursery" (Wells and Blancher 2011, Blancher and Wells 2005). Along with birds, the boreal forest also harbors many of the world's last healthy populations of large predators, including grizzly bears, wolverine, timber wolves, and polar bears (Bradshaw et al. 2009, Cardillo et al. 2006, Wells et al. 2013). And it is globally-recognized as one of the world's last strongholds for migratory mammals, particularly for herds of caribou, collectively numbering in the millions—that travel thousands of miles each year between northern calving grounds and southern wintering areas (Hummel and Ray 2008, Wilcove 2008).

In addition to its value for wildlife, the boreal provides mankind with globally important ecosystem services. Canada's portion of the boreal forest (about 85 percent of the total), a focus of this report, is one of the world's largest storehouses of carbon. It contains 25% of the world's wetlands, and stores more surface freshwater than anywhere else on Earth. These pristine wetlands and waterways also provide nutrient inputs that fuel some of the world's most important marine areas (Wells et al. 2011, Carlson et al. 2009, Bradshaw et al. 2009). Together, these and other forms of natural capital in Canada's boreal forest alone are estimated to be worth \$700 billion per year (Anielski and Wilson 2009).

How do we maintain these vital conservation features? The question is one that few areas of the world have an opportunity to consider except in hindsight, because most of the world's ecosystems were either lost or degraded before scientists had described and understood their full ecological roles.

A range of new science published in recent decades shows that much larger proportions of the boreal forest must remain ecologically intact and free from large scale industrial disturbance than had previously been assumed if it is to have a high probability of maintaining the full suite of conservation values of a large landscape region (Locke 2013). According to a 2013 report by the International Boreal Conservation Science Panel (IBCSP): "Maintaining the full complement of species, communities and ecosystem services in the Canadian Boreal Forest requires that at least half of the area be protected from industrial disturbance" (IBCSP 2013).



Western Flyway
 Central Flyway
 Eastern Flyway

THE BOREAL FOREST: NORTH AMERICA'S BIRD NURSERY

Each fall 3-5 billion birds, adults and their young, migrate south out of the boreal forest toward their wintering habitat.

WINTER DESTINATIONS OF BOREAL LANDBIRDS

About 90% of all bird species and individuals leave their breeding grounds in the North American Boreal Forest after the summer breeding season. For landbirds alone, the top five destinations are (Blancher 2003):

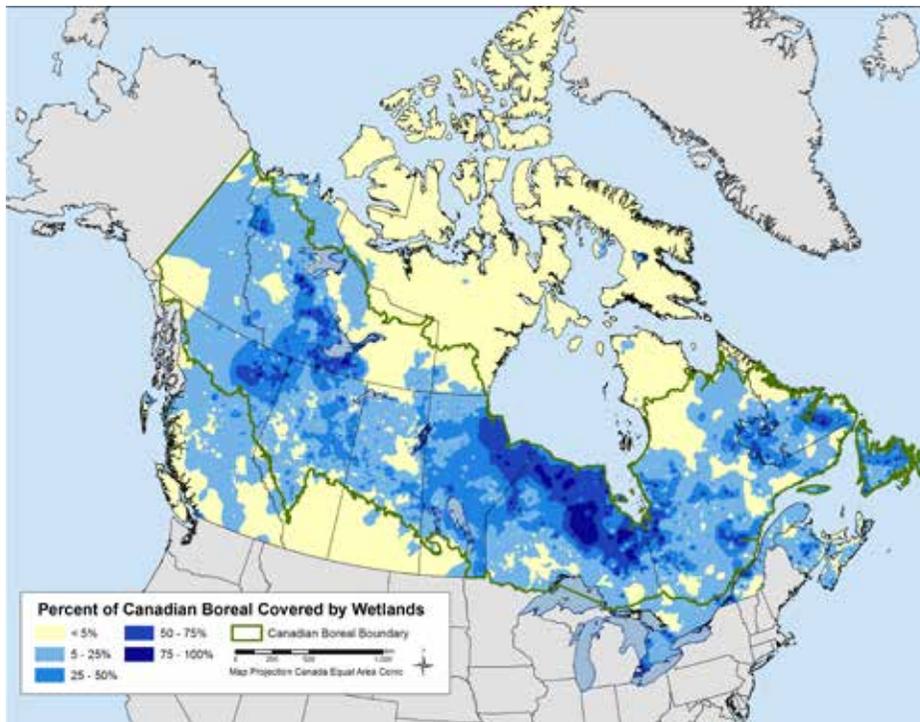
DESTINATION	EST. NUMBER OF WINTERING BIRDS
USA	1,150,000,000
MEXICO	680,000,000
BRAZIL	200,000,000
COLUMBIA	110,000,000
VENEZUELA	60,000,000

Most songbirds and waterfowl breeding in the boreal forest occur in low densities over very large areas (Wells and Blancher 2011, Slattery et al. 2011). This is unlike colonially nesting species or species whose preferred habitat is concentrated within a limited area, which makes them more amenable to localized, smaller-scale habitat conservation measures to protect their nesting grounds. Conservation of boreal birds, in contrast, requires expansive landscape-scale habitat conservation to ensure that

a large proportion of the breeding populations are maintained within areas free of large-scale industrial development (Wells 2011). There is a rich scientific literature showing how bird populations are impacted by the fragmentation, loss, and degradation of their habitat that follows from various kinds of landscape changes, especially those resulting from increased road building, forest cutting or conversion, and other forms of industrial land use (Hagen et al. 2012, Jackson and Fahrig 2011, Smith et al. 2011, Lindenmayer and Fisher 2006, Fahrig 2003). Maintaining at least 50% of the boreal forest region in large, interconnected protected areas is essential to maintain healthy populations of the full diversity of boreal birds. As climate change continues to push bird ranges systematically northwards—nearly 60% of North America’s wintering bird species have been documented doing so because of climate change (National Audubon Society 2009)—these large and still-intact landscapes of forests, wetlands, rivers, and lakes will become increasingly important reservoirs of habitat to support bird populations that can remain resilient to the changes underway.

It was once thought that conserving 10-12% of a region’s land base would be sufficient to maintain its biodiversity and ecological processes. However, this land conservation benchmark is now known to be a significant underestimate (Gaston 2003, Justus et al. 2008). If 10% of an ecological landscape were maintained in a natural state while the remainder was heavily

impacted, approximately half of the original species of the area could be lost (Svancara et al. 2005, Soulé and Sanjavan 1998). Modern, comprehensive conservation plans typically identify protection targets between 25% to 75% of the landscape (Noss and Cooperrider 1994), with a median protection objective above 50% (Schmiegelow et al. 2006, Locke 2013). To maintain the full suite of birds, other biodiversity, and ecological features and functions of the North American boreal forest, at least half of the landscape should be maintained free of large-scale industrial disturbance, while areas used for development should be managed using leading edge sustainability standards.



Canada's boreal forest has some of the most extensive wetlands on Earth. These wetlands provide invaluable feeding and nesting grounds for waterfowl and shorebirds, while the high number of insects produced by these wetlands provide food for a variety of songbirds.

NORTH AMERICA'S BIRD NURSERY

More than 300 bird species nest in or regularly migrate through the North American boreal forest.

These species represent amazing diversity, from waterfowl and shorebirds to hawks, owls, grouse, woodpeckers, warblers, sparrows, finches, and more (Wells and Blancher 2011). Most of these species migrate south from the boreal region in winter. After a successful nesting season, as many as 3-5 billion birds (adults and young of the year) leave the region and become key parts of ecological communities stretching from southern Canada and the United States all the way down to the southern tip of South America (Robertson et al. 2011, Cheskey et al. 2011). An estimated 1 billion of these birds winter in the United States, inhabiting every state from coast to coast (Blancher 2003). Many birders enjoying the winter birds of Florida, or other parts of the southeast U.S., have marveled that every bush can appear to contain a Palm Warbler or Yellow-rumped Warbler—species that rely on the boreal forest to support the bulk of their world population. The remaining billions become integrated in southern bird communities from Mexico to Patagonia, with exceptional concentrations in Mexico, Central America, and northern South America (Robertson et al, 2011). The boreal-dependent Cape May Warbler is one of the most common wintering birds of Cuba, the Dominican Republic, and Haiti. Few wetlands in the Caribbean, Central America, and northern South America are without Greater or Lesser Yellowlegs—shorebird species that nest almost exclusively in bogs and fens within the North American boreal forest. A few species that breed in the North American boreal region even migrate beyond the Americas, traveling to distant places such as New Zealand, Australia, and Africa.

Some 96 bird species are particularly reliant on the North American boreal forest, with more than 50% of their population relying on the region for breeding (Wells and

© Jeff Nadler



An estimated 87% of Bufflehead breed in the boreal forest.



Wetlands in the Northwest Territories

© CHAD DELANY

BIG BOREAL BREEDERS

SPECIES WITH MORE THAN 80% OF THEIR ESTIMATED WESTERN HEMISPHERE BREEDING POPULATION IN THE NORTH AMERICAN BOREAL FOREST

Surf Scoter
White-winged Scoter
Black Scoter
Bufflehead
Common Goldeneye
Spruce Grouse
Red-necked Grebe
Whooping Crane
Lesser Yellowlegs
Solitary Sandpiper
Surfbird
Short-billed Dowitcher
Bonaparte's Gull
Herring Gull
Great Gray Owl
American Three-toed Woodpecker
Black-backed Woodpecker
Yellow-bellied Flycatcher
Alder Flycatcher
Northern Shrike
Philadelphia Vireo
Gray Jay
Boreal Chickadee
Bohemian Waxwing
Tennessee Warbler
Cape May Warbler
Palm Warbler
Blackpoll Warbler
Connecticut Warbler
Lincoln's Sparrow
White-throated Sparrow
Dark-eyed Junco
Rusty Blackbird
Pine Grosbeak
White-winged Crossbill

Blancher 2011). Many are among the most familiar to bird enthusiasts across southern Canada and the United States. Dark-eyed Juncos, for example, are one of the most commonly seen birds in backyards across the United States, in no small part because it's estimated the North American boreal forest supports more than 100 million of them as summer breeders (Partners in Flight Science Committee 2013). During spring migration, birders thrill to the opportunity of seeing the stunning beauty, diversity, and abundance of boreal forest warblers and other songbirds at migration hot spots throughout the United States and Canada. Famous birding locations, including High Island in Texas, Cape May in New Jersey, Fort Desoto in Florida, Central Park in New York City, Kennesaw Mountain in Georgia, Mt. Auburn Cemetery near Boston, the Magic Hedge along Chicago's waterfront, or the Black Swamp in Ohio, would not be the same without the flood of billions of boreal songbirds passing through the United States on their way north each spring.

And it is not just songbirds that split their time between northern boreal breeding grounds and their southern winter homes. Ducks, geese, loons, grebes, and other waterbirds from the boreal forest become familiar and beloved winter and migrant birds of southern Canada, the United States, and beyond. Black, White-winged, and Surf Scoters, Common Goldeneye, and Bufflehead nest almost exclusively in the boreal but become some of the common winter ducks of both the Pacific and Atlantic coasts. Boreal-nesting waterfowl and other waterfowl are some of the signature species of famously important coastal wetland complexes, including San Francisco Bay, Puget Sound, Delaware Bay, Chesapeake Bay, the Gulf Coast and Mexico's Baja Peninsula. Even well-known ducks like Mallard, Northern Pintail, and Northern Shoveler have large breeding populations numbering in the millions within the North American boreal forest (Slattery et al. 2011). The American Black Duck is now particularly reliant on the eastern boreal region as its primary nesting area, as various factors have decreased breeding populations in the United States' portion of its breeding range (Wells 2007). In total, 80% of North America's waterfowl species breed in the boreal region, reinforcing its reputation as a haven for migratory waterfowl (Blancher and Wells 2005).

Unfortunately, many birds that rely on the North American boreal forest are showing major declines. Canada's federal list of endangered, threatened, and special concern birds now includes iconic boreal songbirds such as Olive-sided Flycatcher, Canada Warbler, and Rusty Blackbird—all of which are estimated to have declined by more than two-thirds over recent decades (Cheskey et al. 2011, Wells 2007). The Evening Grosbeak, a favorite boreal bird among winter backyard bird-feeding enthusiasts, has declined by more than 70% (Bonter and Harvey 2008). Boreal-breeding waterfowl are also in trouble, with scaup showing declines of more than 50% and scoters more than 80%, while eastern populations of boreal specialist Harlequin Ducks and Barrow's Goldeneye are federally listed as species of special concern in Canada.

Habitat loss and change within these species' wintering and breeding grounds are important factors in their declines and in the ability of their populations to remain resilient. Protecting their summer nesting habitat in the boreal forest provides the best chance to ensure their long-term survival.

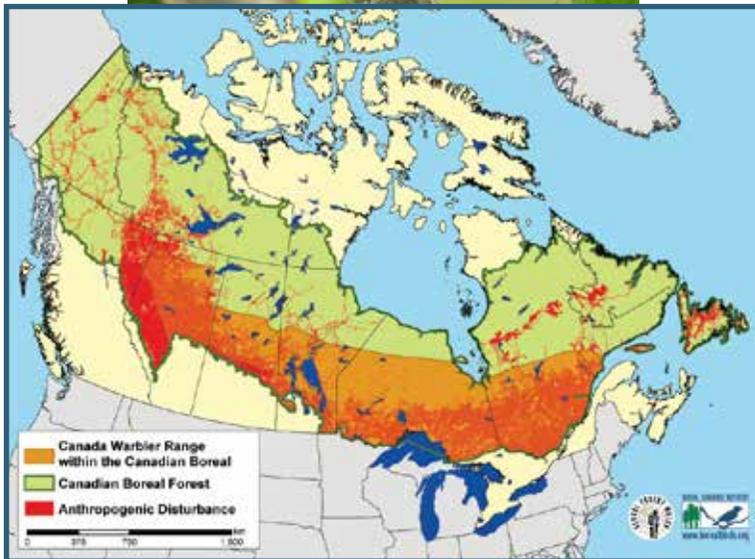
ICONIC BOREAL BIRDS UNDER THREAT

Some of the Boreal's Most Iconic Birds are Declining and Currently Have Low Levels of Habitat Protection

CANADA WARBLER



© Jeff Nadler

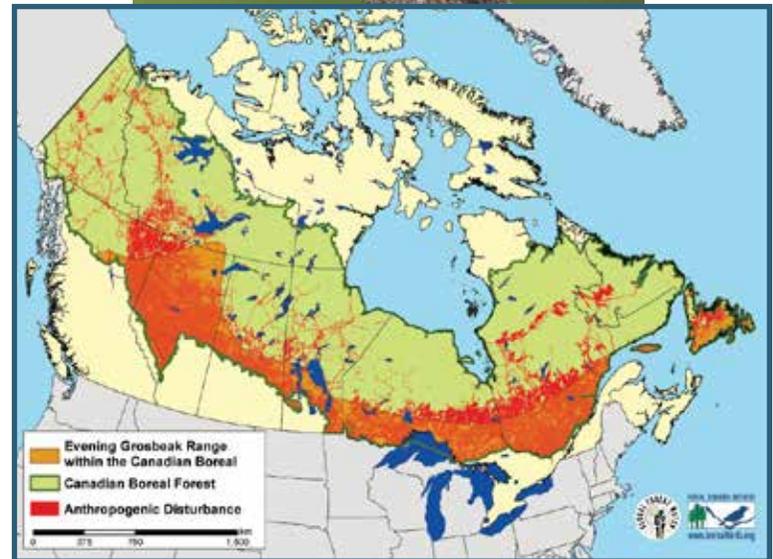


- 80% OVERALL POPULATION DECLINE
- ONLY 7% OF ITS BOREAL FOREST HABITAT IS PROTECTED

EVENING GROSBEAK



© Garth McElroy



- 78% OVERALL POPULATION DECLINE
- ONLY 9% OF BOREAL FOREST HABITAT IS PROTECTED

BIRDS AND THE ABORIGINAL WAY OF LIFE

Another critical role boreal birds provide is their deep, long-lasting relationship with Aboriginal Peoples that dates back for millenia.

The Aboriginal Peoples of Canada's North have a deep, long-lasting relationship with boreal birds, one that dates back for millennia and plays a critical role in their culture. For the hundreds of Aboriginal communities distributed throughout the boreal forest in Canada (Canadian Boreal Initiative 2014), birds are integral to both their physical subsistence and their spiritual connection to the land.

© Natasha Moine



First Nations have been relying on the boreal forest for thousands of years.

To most of the boreal's Aboriginal Peoples, the forest ecosystem and their traditional culture are one and the same. Birds are heavily intertwined with their overall way of life and form a vital part of their worldview. Many Dene, for example, consider loons to be sacred. Elders would listen to loons speaking to find out what was happening around the water (Athabasca Chipewyan First Nation 2003). Ravens are also considered reincarnations of elders in many boreal Aboriginal communities. These are just some of many examples of birds being held in sacred regard to Aboriginal communities throughout the boreal.

Bird hunts demonstrate the physical and spiritual connection that the boreal region's Aboriginal Peoples have with birds. Hunting and harvesting birds not only provides a vital source of food and supplies for many Aboriginal communities, it also ties communities together and encourages longstanding traditional practices. Lillian Trapper of Moose Cree First Nation in Ontario's far north explains this fusion where subsistence and spirit coexist:

"Geese are a main staple food for the people of James Bay. During the spring goose migration, community schools close up to two weeks as most people are out on the land at their family camps for the spring goose hunt. This is one of the people's most important seasonal cultural events. It's a time for gathering, sharing, learning, and reconnecting ourselves to the land. Knowledge of values and morals are passed on and the traditional teachings associated with the hunt are shared that include respect, patience, honour, and gratefulness, to name a few [...] The goose hunt is not just a goose hunt. There is so much more as it is a lifestyle from our ancestors and for our future generations as well [...] Geese are so important to us that you can say that it's in our blood" (Cheskey et al. 2011).

Although many of the values birds provide are quantifiable in environmental or economic terms, the connection between the Aboriginal Peoples of the boreal forest and birds is not. It is abundantly clear, however, that birds are an integral part of the health and well-being of Aboriginal communities throughout the boreal. Healthy and productive bird populations in the boreal forest support the continuation of traditional and spiritual practices that have been taking place for thousands of years, contributing to the well-being and sustainability of the rich Aboriginal cultures of the boreal.





Taku River watershed.

© David Nunuck

LEADING THE WAY

A Balanced Approach to the Future of the Boreal Forest Region

Clearly the North American boreal forest is one of the Earth's most critically important areas for birds, other wildlife, and myriad ecosystem functions. The best available conservation science indicates that in order to ensure these values have the highest probability of being retained, at least half of the region should remain free of large-scale industrial development. Areas used for development should be managed with the utmost care to ensure the least-lasting impact. Fortunately, there are many leaders from Aboriginal communities and governments, industry, other key sectors, and state, provincial, and federal governments who have a vision for this kind of balanced approach to the future of the North American boreal forest (IBCSP 2013).

Aboriginal communities and governments in Canada have shown particularly impressive leadership around smart, effective, and balanced land-use planning toward maintaining the long-term prosperity of human and ecological communities.

- The Broadback Watershed Conservation Plan prepared by the Cree Nation of Quebec has proposed the conservation of more than 20,000 km² (5 million acres), half of which will consist of parks and protected areas while the other half will consist of a special management zone.
- The First Nations of the proposed Pimachiowin Aki World Heritage Site in western Ontario and eastern Manitoba—Pigangikum, Poplar River, Bloodvein, Paungassi, and Little Grand Rapids—have collectively finalized land use plans with over 60% of their traditional territory in conservation areas, an area of more than 19,700 km² (4.9 million acres).
- The Peel River Watershed Planning Commission, with representation from a number of First Nations, has proposed that 80% of the Peel River Watershed in the Yukon—an area of 53,789 km² (13 million acres)—be protected. The Government of Yukon has unfortunately expressed opposition to the plan.
- The Deh Cho First Nation in the Northwest Territories completed its land-use plan, calling for 50% of its traditional territory—an area of more than 100,000 km² (24.7 million acres)—to be in protected areas, though the area included was decreased under pressure from Canada's federal government.
- The Taku River Tlingit First Nation in British Columbia identified 55% of their lands for conservation status in their land-use plan, an area of more than 5,600 km² (1.4 million acres). Their recent compromise agreement with the Government of British Columbia provides for protection of about 25% of their lands.
- The Innu Nation in Labrador created a Forest Ecosystem Strategy Plan that calls for more than 50% of the 71,000-km² (17.5 million-acre) agreement area to be protected for ecological or cultural values—an area of 35,000 km² (8.6 million acres).
- The Nunatsiavut Government endorsed the Labrador Inuit Settlement Area proposed land-use plan. It calls for 40% of the 72,599-km² (17.9 million-acre) area—29,000 km² (7 million acres)—to be off-limits to large-scale industrial development, but is now facing opposition to the plan from the Government of Newfoundland and Labrador (IBCSP 2013).



© Jeff Wells

Youth from Tulita, Northwest Territories, banding ducks at Willow Lake.

RECOMMENDATIONS FOR MAINTAINING NORTH AMERICA'S BIRD NURSERY

To ensure that an abundant and diverse population of birds is maintained, the following principles should be applied:



© Jeff Nadler

Conserving at least half of the boreal forest would give North America's birds the best fighting chance against the double-edged threat of habitat loss and climate change.

- 1.** At least half of the boreal forest region must remain free of large-scale industrial disturbance. That level of protection is necessary to guarantee a high probability of maintaining healthy populations of the full spectrum of bird species and other wildlife inhabiting the North American boreal forest;
- 2.** Industrial activities undertaken in the remaining unprotected areas should be carried out with the highest global sustainability standards, with an emphasis on maintaining healthy and pristine wetlands and waterways;
- 3.** Both protected areas and industrial activities should proceed only with the free, prior, and informed consent of affected Aboriginal communities.

Canada has the opportunity to become a world leader in conservation and sustainable development. However, there is an urgent need for leadership to ensure that the North American boreal forest—a global treasure—is protected for future generations.

A Continental Snapshot of North America's Boreal Forest Region



*Nahanni National Park in the
Northwest Territories.*

© Steve Kallick



In this section we profile the Canadian provinces and territories with significant blocks of boreal forest habitat and provide key facts about the boreal forest in each region.^{1, 2, 3, 4}

Although each province and territory includes a multitude of important areas for birds and other wildlife, we highlight one or two significant areas and their corresponding bird species to showcase how the variety of landscapes and biodiversity makes the boreal forest such a special place.

¹ Provincial boreal forest size and intactness approximations based on: Global Forest Watch Canada. 2009. Canada's Forest Landscape Fragments: A Second Approximation. Global Forest Watch Canada, Edmonton, Alberta.

² Bird populations estimated by applying the percentage of North America's boreal forest present in each province/territory to the high (3 billion) and low (1 billion) total boreal breeding bird population estimates from: Blancher, P. 2003. Importance of Canada's Boreal Forest to Landbirds. Canadian Boreal Initiative, Ottawa, Ontario, and Boreal Songbird Initiative, Seattle, Washington.

³ Carbon storage rate approximations based on: Tarnocai, C. and Lal, E. 2002. Soil Organic Carbon Digital Database of Canada. Eastern Cereal and Oilseed Research Center, Research Branch, Agriculture and Agri-Food Canada, Ottawa, Ontario.

⁴ Canada's annual carbon emissions from the burning of fossil fuels at 2008 levels based on: Boden, T.A., G. Marland, and R.J. Andres. 2011. Global, Regional, and National Fossil-Fuel CO₂ Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee.



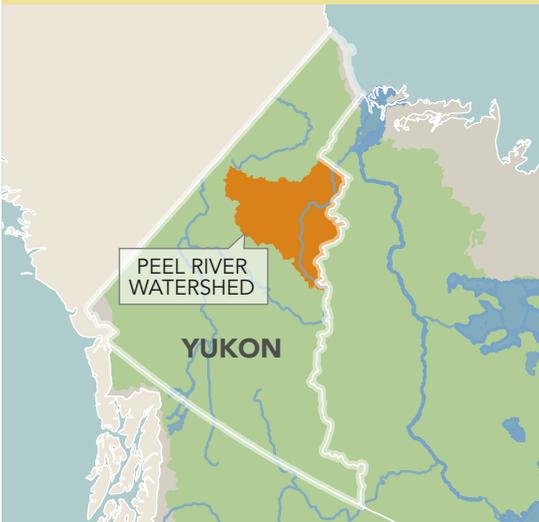
© Jeff Neidler

YUKON

PEEL RIVER WATERSHED

Olive-sided Flycatcher

From rugged mountain peaks and high plateaus to deep canyons and sprawling river valleys, the **Peel River Watershed** provides ideal habitat for a wide variety of raptors and songbirds, including the rapidly declining **Olive-sided Flycatcher**.



YUKON'S BOREAL FOREST:

- Is 465,000 km² (115 million acres) in size, 95% of which is still intact.
- Is the breeding ground for 80 to 240 million birds of more than 150 bird species, including Olive-sided Flycatcher, Townsend's Solitaire, Blackpoll Warbler, Smith's Longspur, and Rusty Blackbird.
- Stores 7 billion tonnes of carbon in its soils, peat, and forests, equivalent to 47 years of Canada's annual carbon emissions from the burning of fossil fuels.



© Aljandro Erickson/
Wikimedia Commons

BRITISH COLUMBIA

SACRED HEADWATERS

Golden-crowned Sparrow

The three pristine river watersheds – the Skeena, Nass, and Stikine – that cut through the rugged peaks of the **Sacred Headwaters** region are known for their strong salmon runs, but also provide critical habitat for mountain-loving birds such as the **Golden-crowned Sparrow**.



BRITISH COLUMBIA'S BOREAL FOREST:

- Is 299,000 km² (74 million acres) in size, 71% of which is still intact.
- Is the breeding ground for 50 to 150 million birds of approximately 170 species, including Olive-sided Flycatcher, Wilson's Warbler, Blackpoll Warbler, and Rusty Blackbird.
- Stores 5 billion tonnes of carbon in its soils, peat, and forests, equivalent to 33 years of Canada's annual carbon emissions from the burning of fossil fuels.



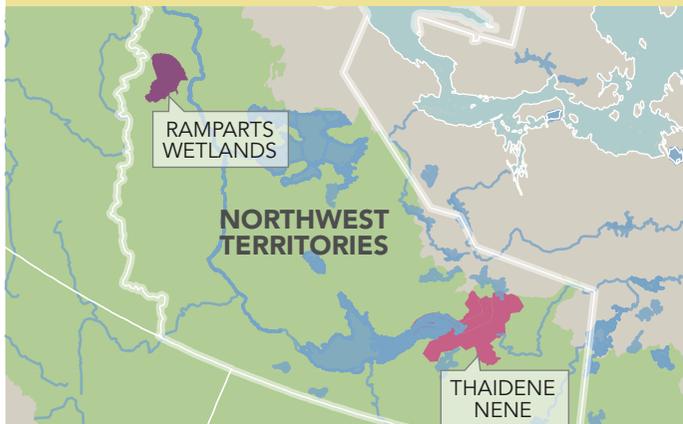
NORTHWEST TERRITORIES

RAMPARTS WETLANDS AND THAIDENE NENE

Pacific Loon and Arctic Tern

The **Ramparts Wetlands** feature vast expanses of wetlands, marshes, and shallow open ponds that provide invaluable nesting habitat to a wide variety of waterbirds, especially wigeon, scoters, and others such as the **Pacific Loon**.

Thaidene Nene features dramatic rocky bluffs along the eastern portion of Great Slave Lake and extends northeast through sparsely wooded forest, open tundra, and a myriad of smaller lakes that provide prime nesting habitat for the **Arctic Tern**.



NORTHWEST TERRITORIES' BOREAL FOREST:

- Is 950,000 km² (235 million acres) in size, 88% of which is still intact.
- Is the breeding ground for 150 to 500 million birds of more than 200 species, including White-winged Scoter, Arctic Tern, Blackpoll Warbler, Harris's Sparrow, and Rusty Blackbird.
- Stores 40 billion tonnes of carbon in its soils, peat, and forests, equivalent to 269 years of Canada's annual carbon emissions from the burning of fossil fuels.



ALBERTA

WOOD BUFFALO NATIONAL PARK

Whooping Crane

Wood Buffalo National Park, Canada's largest protected area, is most well known for containing the largest remaining roaming herd of Wood Bison and the last historic breeding habitat for the endangered **Whooping Crane**.



ALBERTA'S BOREAL FOREST:

- Is 465,000 km² (115 million acres) in size, 35% of which is still intact.
- Is the breeding ground for 80 to 240 million birds of more than 200 species, including Whooping Crane, Short-billed Dowitcher, Bay-breasted Warbler, Canada Warbler, and Rusty Blackbird.
- Is home to the Peace-Athabasca Delta, one of North America's most important migratory stopover areas for numerous boreal and Arctic species of waterfowl and shorebirds.
- Stores 14 billion tonnes of carbon in its soils, peat, and forests, equivalent to 94 years of Canada's annual carbon emissions from the burning of fossil fuels.



© Flickr.com/NDome73

SASKATCHEWAN

SASKATCHEWAN RIVER DELTA

Ring-necked Duck

The interwoven complexes of swamps, marshes, and fens throughout the **Saskatchewan River Delta** make it one of the most important breeding and staging grounds for waterfowl in the boreal, particularly for the **Ring-necked Duck**.



SASKATCHEWAN'S BOREAL FOREST:

- Is 410,000 km² (101 million acres) in size, 76% of which is still intact.
- Is the breeding grounds for 70 to 200 million birds of more than 175 species, including threatened species like Yellow Rail, Canada Warbler, and Olive-sided Flycatcher and specialized species like Bonaparte's Gull and Great Gray Owl.
- Stores 5 billion tonnes of carbon in its soils, peat, and forests, equivalent to 33 years of Canada's annual carbon emissions from the burning of fossil fuels.



© Garth McElroy



© Garth McElroy

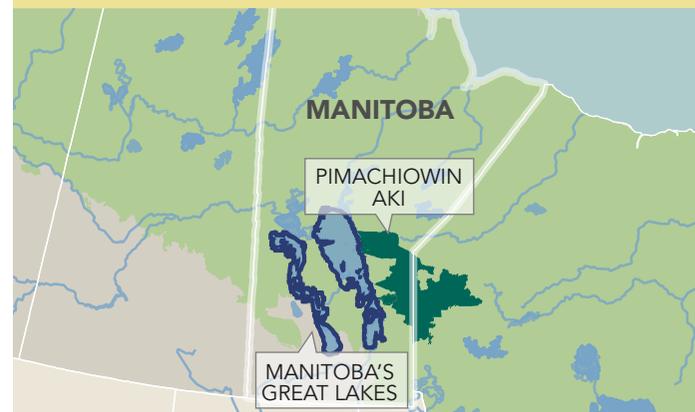
MANITOBA

PIMACHIWIN AKI AND MANITOBA'S GREAT LAKES

Great Gray Owl and Common Tern

Pimachiowin Aki offers a rare and diverse combination of habitat within one of the largest blocks of intact southern boreal forest left on Earth, supporting impressive populations of birds including the iconic **Great Gray Owl** and the threatened Olive-sided Flycatcher.

The shorelines of **Manitoba's Great Lakes** offer some of the longest and most productive freshwater coastal wetlands in the world and provide remarkable habitat for a variety of waterbirds, including the **Common Tern**.



MANITOBA'S BOREAL FOREST:

- Is 570,000 km² (141 million acres) in size, 82% of which is still intact.
- Is the breeding grounds for 100 to 300 million birds of more than 250 species, including threatened species like Yellow Rail, Canada Warbler, and Olive-sided Flycatcher and specialized species like Hudsonian Godwit, LeConte's Sparrow, Connecticut Warbler, Bonaparte's Gull, and Great Gray Owl.
- Stores 19 billion tonnes of carbon in its soils, peat, and forests, equivalent to 128 years of Canada's annual carbon emissions from the burning of fossil fuels.



© Flickr.com/nebirdspilus

ONTARIO

HUDSON AND JAMES BAY LOWLANDS

Hudsonian Godwit

The **Hudson and James Bay Lowlands** form the third largest wetland network on earth, the shorelines of which offer critical stopover habitat for geese, wigeon, and ducks as well as outstanding breeding habitat for shorebirds like the **Hudsonian Godwit**.



ONTARIO'S BOREAL FOREST:

- Is 862,000 km² (213 million acres) in size, 74% of which is still intact.
- Is the breeding ground for 200 to 400 million birds of more than 250 species, including threatened species like Yellow Rail, Canada Warbler, and Olive-sided Flycatcher as well as boreal forest specialties like Cape May Warbler, Philadelphia Vireo, Tennessee Warbler, Spruce Grouse, Black-backed Woodpecker, and Lincoln's Sparrow.
- Stores 49 billion tonnes of carbon in its soils, peat, and forests, equivalent to 330 years of Canada's annual carbon emissions from the burning of fossil fuels.



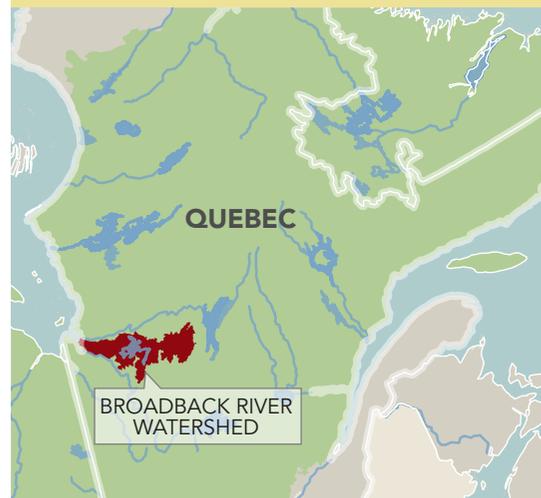
© Jeff Nadler

QUEBEC

BROADBACK RIVER WATERSHED

Canada Warbler

Although logging has slowly crept in from the south, the intact portions of the **Broadback River Watershed** provide ample forest habitat for a wide variety of shorebirds and songbirds, including the threatened **Canada Warbler**.



QUEBEC'S BOREAL FOREST:

- Is 1,200,000 km² (296 million acres) in size, 75% of which is intact
- Is the breeding ground for 300 to 500 million birds of approximately 180 species, including threatened species like Harlequin Duck, Barrow's Goldeneye, Canada Warbler, and Olive-sided Flycatcher as well as favorites like American Black Duck, Lesser Yellowlegs, Yellow-bellied Flycatcher, Boreal Chickadee, Palm Warbler, Orange-crowned Warbler, and Evening Grosbeak.
- Stores 31 billion tonnes of carbon in its soils, peat, and forests, equivalent to 208 years of Canada's annual carbon emissions from the burning of fossil fuels.



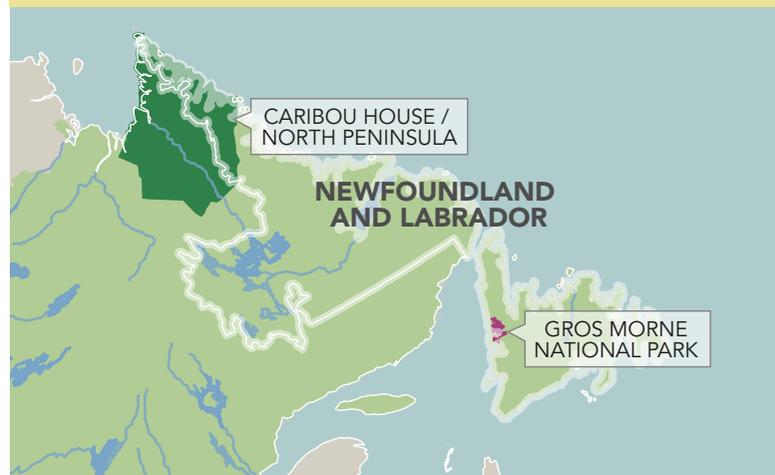
NEWFOUNDLAND AND LABRADOR

CARIBOU HOUSE/NORTH PENINSULA AND GROS MORNE NATIONAL PARK

Golden Eagle and Gray-cheeked Thrush

Although primarily known as the calving grounds of the George River caribou herd, **Caribou House** and the adjacent peninsula also offer critical habitat for songbirds, seabirds, shorebirds, and raptors, such as the **Golden Eagle**.

The stunning inlets, long canyon walls, and rugged peaks of **Gros Morne National Park** attract attention from photographers, but the dramatic terrain also provides breeding grounds for a variety of songbirds, such as the **Gray-cheeked Thrush**.



NEWFOUNDLAND AND LABRADOR'S BOREAL FOREST:

- Is 380,000 km² (94 million acres) in size, 86% of which is still intact.
- Is the breeding ground for 70 to 200 million birds of more than 150 bird species, including Harlequin Duck, Short-eared Owl, Golden Eagle, Olive-sided Flycatcher, Bay-breasted Warbler, American Tree Sparrow, and Rusty Blackbird.
- Stores 21 billion tonnes of carbon in its soils, peat, and forests, equivalent to 141 years of Canada's annual carbon emissions from the burning of fossil fuels.

Why Boreal Birds Matter



IT IS IMPORTANT TO MAINTAIN NORTH AMERICA'S BIRD NURSERY SO THAT BIRDS CAN CONTINUE TO DO A CRUCIAL JOB: KEEPING OUR NATURAL WORLD WORKING AND OUR ECONOMIES HEALTHY.



© Jeff Nadler

Beyond the sheer amazement and awe that birds inspire—with their beauty, colour, song, and flight—birds provide a wide range of critical services, from pollination and pest control to stimulating economic activity in the form of birding and sport hunting. They are also critical drivers of ecosystem health and act as mobile links both within and between regional and larger-scale ecosystems (Lundberg and Moberg 2003), helping to keep entire communities of plant and animal species productive and vibrant.

Boreal-breeding birds provide countless value throughout Canada and the United States, and also in areas from Mexico and the Caribbean all the way down to the southern tip of the Tierra del Fuego. Quite simply, boreal birds are 'worth' substantially more than most people know.

© Jeff Wells



Birding is big business in Canada and the United States, generating more than \$100 billion per year in the United States alone.

ECONOMIC DRIVERS

Birds are big business. Through viewing, feeding, and hunting, large amounts of money are spent on bird-related activities. These expenditures not only boost and help diversify the economy, they also provide vital sources of jobs and income to economically-struggling regions.

In 2011, Americans spent \$34 billion on equipment, food, lodging, transportation, and other expenditures related to hunting and hunting trips. Bird hunters (primarily geese, ducks, and dove) accounted for nearly 20% of that total (U.S. Fish & Wildlife Service 2012). This, in turn, has generated billions of dollars in tax revenue for the U.S. federal government and state governments.

Birding is a wildly popular and profitable activity in the United States. Birders—those people who travelled more than 1 mile from home to view birds or who actively watch and identify birds around home—accounted for roughly 20% of the United States population in 2011, at 47 million individuals (U.S. Fish & Wildlife Service 2013). In the same year, birders spent \$14.9 billion on trip-related expenditures and \$26.1 billion on equipment related to bird watching, for a total of more than \$40 billion. To put this in perspective, this amounts to about five times the total revenue of Major League Baseball in 2013 (Brown 2013).

The U.S. Fish and Wildlife Service estimates that when direct, indirect, and induced effects of these expenditures are included, annually birding as a whole was responsible for \$107 billion in total economic output, 666,000 jobs, and more than \$30 billion in direct employment income (U.S. Fish & Wildlife Service 2013).

And although direct economic figures for birding and waterfowl hunting in Canada are more elusive, it is believed that birds provide

similar economic stimulus. More than 38% of Canadians have observed or cared for birds in and around their home (Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians 2000), while more than 30% of Canadians have participated in wildlife viewing trips (Lang Research Inc. 2006)—of which birds were a commonly cited objective. Many hunting lodges and eco-lodges are sprinkled throughout the rural regions of the Canadian Boreal Forest, providing important income to rural communities.

These statistics demonstrate that successful conservation, habitat management, and restoration efforts provide significant economic value over the long term. The more birds there are for people to enjoy, both through viewing and through sport hunting, the more people will continue to spend money on these activities. This has a ripple effect throughout entire economies, increases tax revenues, and provides jobs and income to thousands of individuals, many of whom reside in rural areas with struggling economies.

© Garth McElroy



Cape May Warblers are one of the more well-known nectar feeders.

PLANT POLLINATORS

Ecosystems are typically very complex and often highly fragile. In many cases, balances among species diversity and food and nutrient chains have been built up and sustained over thousands of years, if not longer. Disruptions to these systems can lead to severe reductions in overall health and biodiversity among both plant and animal species throughout the region. In almost every ecosystem, birds play a fundamental role in supporting and sustaining healthy plant life, subsequently helping to sustain countless additional fauna. The most immediate and direct role comes in the form of pollination and seed distribution.

Birds are believed to act as pollinators for between 3.5-5.4% of the 1,500 most common crops and medicinal plants globally, around three-quarters of which are unable to self-pollinate on their own (Nabhan and Buchmann 1997). Boreal birds like Cape May Warblers, which winter in the Caribbean, and Tennessee Warblers, which winter in Central America, are well-known nectar feeders on their wintering grounds and are likely to play a major role as pollinators within the tropical ecosystems that they inhabit (Robertson et al. 2011).

© Jeff Nadler



The Swainson's Thrush and other fruit and seed eaters are critical to maintaining tree diversity in the tropics.

SEED DISPERSAL

In addition to acting as cross-pollinators, birds provide an invaluable service for the world's plant life by distributing seeds. Although some plants and trees are able to rely on short-range dispersal (i.e. dropping fruit or seeds) and wind, many rely on animals to disperse their seeds over wider areas. In general, birds are arguably the most abundant and the most capable of transferring seeds over longer distances and diverse terrain, maximizing the chances of reproductive success.

Many of the most abundant boreal species within wintering bird communities are fruit or seed eaters. Tree diversity in tropical forests is often highly reliant on the ability of birds and mammals to distribute the seeds of fruits during the feeding process or through their droppings. The Swainson's Thrush, for example—which has much of its breeding population in the boreal forest region and may number more than 100 million—is a fruit and berry eater on its South American wintering grounds. Many boreal birds that are primarily insect eaters on their breeding grounds often eat much more fruit on their wintering grounds. This includes flycatchers, including the Olive-sided Flycatcher and Eastern Kingbird.

© Jeff Nadler



Waterfowl, seabirds, and shorebirds such as the Short-billed Dowitcher remove nutrients from water bodies and return them to land.

NUTRIENT REDISTRIBUTORS

It is widely known that adding fertilizers to lawns or gardens increases plant productivity and growth. What is less known is that birds—seabirds, shorebirds, and waterfowl especially—have already been doing this for thousands, if not millions, of years through nutrient depositing and cycling.

The predominant form of nutrient cycling occurs when birds extract high concentrations of nutrients out of water bodies (oceans, lakes, rivers, and wetlands) for consumption. Nutrient-rich foods such as fish, shellfish, and other aquatic organisms are brought onto land either in the form of food scraps or droppings. The nutrients subsequently support plant productivity and the food scraps support small mammals and insects. Bald Eagles and Osprey are among many birds that feed predominantly on fish removed from rivers and lakes and carried overland to nesting and feeding sites. In some southern portions of the boreal forest, Turkey Vultures are important scavengers of fish and animal remains.

Wetlands, which are among the most prolific ecosystems globally in terms of biodiversity and ecological functions, benefit from the presence of waterbirds. Both wetland productivity and fish production are believed to be enhanced by the presence of colonial waterbirds through the input and cycling of nutrients (Green and Elmberg 2014). The North American Boreal Forest hosts major breeding and migratory staging concentrations for many of these aquatic nutrient distributors, including White Pelicans, Double-crested Cormorants, Common Terns, Arctic Terns, Ring-billed Gulls, Herring Gulls, and many others. The staggeringly high number of waterfowl and other waterbirds that breed in the boreal forest each year allow coastlines and wetlands throughout North America to continue to remain healthy and productive.

© Garth McElroy



Evening Grosbeaks are highly effective at managing Western spruce budworm outbreaks.

PEST CONTROL

The Western spruce budworm is believed to be the most widely distributed and most destructive pest on coniferous forests in the United States (U.S. Forest Service 2014), severely restricting harvestable forest and degrading other natural areas. In a study of two Washington state forest stands, birds were found to be remarkably efficient at reducing spruce budworms, particularly the boreal-breeding Evening Grosbeak. When the reduction of budworms was compared to the potential cost for insecticide treatment to reach similar levels of effectiveness, it was estimated that birds were providing a \$10,360 per-square-mile (\$4,000 per-km²) natural service over 100-year tree cycles when adjusted for inflation (Takekawa and Garton 1984).

The mountain pine beetle is another pest that has long worried forest managers and timber companies alike, having ravaged extensive stands of forest throughout the Western United States and Canada. Woodpeckers, especially the boreal-dependent Three-toed Woodpecker, are extremely effective at reducing pine beetles and lessening the extent of outbreaks (Fayt et al. 2005). In fact, the Canadian government believes that woodpeckers can consume up to 30% of pine beetles in areas experiencing outbreak (Parks Canada 2014), proving birds to be an invaluable ally in the sustainable management of our continent's forests.

© Garth McElroy



Common Loons have helped educate people about mercury contamination in the Adirondack Mountains.

ENVIRONMENTAL INDICATORS

The phrase "a canary in a coal mine" may have originated as a way to determine if coal mines were safe for humans to enter, but the usefulness of birds acting as environmental indicators spreads far beyond just that example. Boreal-breeding birds such as Tree Swallows have been studied around the Great Lakes and Hudson River as good indicators of chemical contaminant exposure in surrounding landscapes (McCarty 2002), helping to alert authorities to spikes in local contamination. The documented effects of mercury on Common Loons in the Adirondack Mountains of New York have also heightened awareness about mercury contamination throughout the region (Schoch and Jackson 2011). And due to their reliance on healthy, productive forests and their sensitivity to development and land-use change, woodpeckers are considered great indicators of overall forest health (Mikuski ski 2006).

LITERATURE CITED

- Anielski, M., and S. Wilson. 2009. *Counting Canada's natural capital: assessing the real value of Canada's boreal ecosystems*. Canadian Boreal Initiative and Pembina Institute, Ottawa, Ontario.
- Athabasca Chipewyan First Nation. 2003. *Traditional Land Use Study*. Fort Chipewyan, Alberta.
- Blancher, P. 2003. *Importance of Canada's Boreal Forest to Landbirds*. Canadian Boreal Initiative, Ottawa, Ontario, and Boreal Songbird Initiative, Seattle, Washington.
- Blancher, P., and J. Wells. 2005. *The Boreal Forest Region: North America's Bird Nursery*. Canadian Boreal Initiative, Ottawa, Ontario, and Boreal Songbird Initiative, Seattle, Washington.
- Boden, T.A., G. Marland, and R.J. Andres. 2011. Global, Regional, and National Fossil-Fuel CO₂ Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee.
- Bonter, D.N., and M.G. Harvey. 2008. Winter survey data reveal rangewide decline in Evening Grosbeak populations. *The Condor* 110(2):376-381.
- Bradshaw, C.J.A., I.G. Warkentin, and N.S. Sodhi. 2009. Urgent preservation of boreal carbon stocks and biodiversity. *Trends in Ecology and Evolution* 24: 541-548.
- Brown, M. 2013. *Major League Baseball Sees Record Revenues Exceed \$8 Billion for 2013*. Forbes (December 17, 2013). <http://www.forbes.com/sites/maurybrown/2013/12/17/major-league-baseball-sees-record-revenues-exceed-8-billion-for-2013/> (Accessed March 2014).
- Canadian Boreal Initiative. 2014. *About Canada's Boreal: Boreal Peoples*. Canadian Boreal Initiative, Ottawa, Ontario. <http://www.borealcanada.ca/boreal-people-e.php> (Accessed March 2014).
- Cardillo, M., G.M. Mace, J.L. Gittleman, and A. Purvis. 2006. Latent extinction risk and the future battlegrounds of mammal conservation. *Proc. Nat. Acad. Sci.* 103:4157-4161.
- Carlson, M., J.V. Wells, and D. Roberts. 2009. *The Carbon the World Forgot: Conserving the Capacity of Canada's Boreal Forest Region to Mitigate and Adapt to Climate Change*. Canadian Boreal Initiative, Ottawa, Ontario, and Boreal Songbird Initiative, Seattle, Washington.
- Cheskey, E., J. Wells, and S. Casey-Lefkowitz. 2011. *Birds at Risk: The Importance of Canada's Wetlands and Waterways*. Nature Canada, Ottawa, Ontario, Boreal Songbird Initiative, Seattle, Washington, and Natural Resources Defense Council, Washington, DC.
- Fahrig, L., 2003. Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology Evolution and Systematics* 34:487-515.
- Fayt, P., M.M. Machmer, and C. Steeger. 2005. Regulation of spruce bark beetles by woodpeckers—a literature review. *Forest Ecology and Management* 203(1-3):1-14.
- Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians. 2000. *The importance of nature to Canadians: the economic significance of nature-related activities*. Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians.
- Gaston, K.J. 2003. *The structure and dynamics of geographic ranges*. Oxford University Press: Oxford, United Kingdom.
- Global Forest Watch Canada. 2009. *Canada's Forest Landscape Fragments: A Second Approximation*. Global Forest Watch Canada, Edmonton, Alberta.
- Green, A.J., and J. Elmsberg. 2014. Ecosystem services provided by waterbirds. *Biological Reviews* 89(1):105-22.
- Hagen, M., W.D. Kissling, C. Rasmussen, D.W. Carstensen, Y.L. Dupont, C.N. Kaiser-Bunbury, and J.M. Tylianakis. 2012. Biodiversity, species interactions and ecological networks in a fragmented world. *Advances in Ecological Research* 46:89-120.
- Hummel, M., and J.C. Ray. 2008. *Caribou and the north: a shared future*. Dundurn Press: Toronto, ON. 288 pp.
- International Boreal Conservation Science Panel. 2013. *Conserving the World's Last Great Forest is Possible: Here's How*. International Boreal Conservation Science Panel. <http://borealscience.org/wp-content/uploads/2013/07/conserving-last-great-forests1.pdf> (Accessed March 2014).
- Jackson, N.D., and L. Fahrig. 2011. Relative effects of road mortality and decreased connectivity on population genetic diversity. *Biological Conservation* 144(12):3143-3148.
- Justus, J., T. Fuller, and S. Sarkar. 2008. Influence of Representation Targets on the Total Area of Conservation-Area Networks. *Conservation Biology* 22:673-682.
- Lang Research Inc. 2006. TAMS 2006: *Canadian Activity Profile, Wildlife Viewing While on Trips*. Prepared for: Ontario Ministry of Tourism, Ontario Tourism Marketing Partnership Corporation, Quebec Ministry of Tourism, Travel Manitoba, Canadian Tourism Commission, Tourism Saskatchewan, Atlantic Canada Tourism Partnership, Alberta Tourism, Parks, Recreation and Culture, Department of Canadian Heritage, Tourism British Columbia, Parks Canada Agency, Government of Yukon, Government of Northwest Territories.
- Lee, P., D. Aksenov, L. Laestadius, R. Noguero, and W. Smith. 2006. *Canada's large intact forest landscapes*. Global Forest Watch Canada, Edmonton, Alberta. 84 pp.
- Lindenmayer, D.B., and J. Fischer. 2006. *Habitat Fragmentation and Landscape Change: An Ecological and Conservation Synthesis*. Island Press: Washington, DC.
- Locke, H. 2013. Nature needs half: a necessary and hopeful new agenda for protected areas. *Parks: The International Journal of Protected Areas and Conservation* 19(2):13-22. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.
- Lundberg, J. and F. Moberg. 2003. Mobile Link Organisms and Ecosystem Functioning: Implications for Ecosystem Resilience and Management. *Ecosystems* 6(1):0087-0098.
- Parks Canada. 2014. *Battle in the Bark*. Parks Canada, Gatineau, Quebec. <http://www.pc.gc.ca/eng/docs/v-g/dpp-mpb/sec3.aspx> (Accessed March 2014).
- McCarty, J.P. 2002. Use of tree swallows in studies of environmental stress. *Reviews in Toxicology* 4:61-104.
- Mikusinski, G. 2006. Woodpeckers: distribution, conservation, and research in a global perspective. *Annales Zoologici Fennici* 43:86-95.
- Nabhan, G.P., and S.L. Buchmann. 1997. *Chapter 8: Services Provided by Pollinators*. Pp. 133-150 in: (G. Daily, ed.) *Nature's Services: Societal Dependence On Natural Ecosystems*. Island Press: Washington, DC.
- National Audubon Society. 2009. *Birds and Climate Change: Ecological Disruption in Motion*. National Audubon Society, New York, New York.
- Noss, R.F., and A.Y. Cooperrider. 1994. *Saving nature's legacy: Protecting and restoring biodiversity*. Island Press: Washington, DC.
- Partners in Flight Science Committee. 2013. *Population Estimates Database, version 2013*. Partners in Flight Science Committee. <http://rmbio.org/pifpopestimates> (Accessed March 2014).
- Robertson, B.A., R. MacDonald, J.V. Wells, P. Blancher, and L. Bevier. 2011. *Chapter 7: Boreal migrants in winter bird communities*. Pp. 85-94 in (J.V. Wells, ed.) *Boreal birds of North America*. Studies in Avian Biology (no. 41), University of California Press: Berkeley, California.
- Schmiegelow, F.K.A., S.G. Cumming, S. Harrison, S. Leroux, K. Liso, R. Noss, and B. Olsen. 2006. *Conservation beyond crisis management: A conservation-matrix model*. Edmonton: Canadian BEACONS Project Discussion Paper No. 1.
- Schoch, N., and A. Jackson. 2011. *Adirondack Loons – Sentinels of Mercury Pollution in New York's Aquatic Ecosystems*. BRI Report #2011-29, Biodiversity Research Institute, Gorham, Maine.
- Slattery, S.M., J.L. Morissette, G.G. Mack, and E.W. Butterworth. 2011. *Chapter 3: Waterfowl Conservation Planning: Science Needs and Approaches*. Pp. 23-40 in (J. V. Wells, ed.) *Boreal birds of North America*. Studies in Avian Biology (no. 41), University of California Press: Berkeley, California.
- Soulé, M.E., and M.A. Sanjayan. 1998. Conservation targets: Do they help? *Science* 279:2060-2061.
- Svancara, L.K., R. Brannon, J.M. Scott, C.R. Groves, R.F. Noss, and R.L. Pressey. 2005. Policy-driven versus evidence-based conservation: a review of political targets and biological needs. *Bioscience* 55:989-995.
- Takekawa, J.Y., and E.O. Garton. 1984. How Much is an Evening Grosbeak Worth? *Journal of Forestry* 82(7):426-8.
- Tarnocai, C. and Lacelle, B. 1996. *Soil Organic Carbon Digital Database of Canada*. Eastern Cereal and Oilseed Research Center, Research Branch, Agriculture and Agri-Food Canada, Ottawa, Ontario.
- U.S. Fish & Wildlife Service. 2012. 2011 *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: National Overview*. U.S. Fish & Wildlife Service, Washington, DC.
- U.S. Fish & Wildlife Service. 2013. *Birding in the United States: a Demographic and Economic Analysis* (Report 2011-1). U.S. Fish and Wildlife Service, Washington, DC.
- U.S. Forest Service. 2014. *Western Spruce Budworm*. U.S. Forest Service, Washington, DC. <http://www.fs.fed.us/research/invasive-species/insects/western-spruce-budworm.php> (Accessed March 2014).
- Wells, J.V. 2007. *Birder's Conservation Handbook: 100 North American Birds at Risk*. Princeton University Press: Princeton, New Jersey.
- Wells, J.V. 2011. *Chapter 1: Threats and conservation status*. Pp. 1-6 in (J.V. Wells, ed.) *Boreal birds of North America*. Studies in Avian Biology (no. 41), University of California Press: Berkeley, California.
- Wells, J.V., and P. Blancher. 2011. *Chapter 2: Global role for sustaining bird populations*. Pp. 7-22 in (J. V. Wells, ed.) *Boreal birds of North America*. Studies in Avian Biology (no. 41), University of California Press: Berkeley, California.
- Wells, J.V., D. Roberts, P. Lee, R. Cheng, and M. Darveau. 2011. *A Forest of Blue: Canada's Boreal Forest, the World's Waterkeeper*. Pew Environment Group, Washington, DC.
- Wells, J., F. Reid, M. Darveau, and D. Childs. 2013. *Ten Cool Canadian Biodiversity Hotspots: How a New Understanding of Biodiversity Underscores the Global Significance of Canada's Boreal Forest*. Boreal Songbird Initiative, Seattle, Washington, Ducks Unlimited Inc., Memphis, Tennessee, and Ducks Unlimited Canada, Stonewall, Manitoba.
- Wilcove, D.S. 2008. *No way home: the decline of the world's great animal migrations*. Island Press: Washington, DC.

BOREAL SONGBIRD INITIATIVE

1904 Third Avenue, Suite 305
Seattle, Washington 98101
www.borealbirds.org

DUCKS UNLIMITED INC.

One Waterfowl Way
Memphis, Tennessee 38120
www.ducks.org

DUCKS UNLIMITED CANADA

P.O. Box 1160
Stonewall, Manitoba R0C 2Z0
www.ducks.ca

ACKNOWLEDGEMENTS

The production of this report was truly a team effort and could not have been done without the countless contributions from a variety of talented individuals. The authors would specifically like to thank Lane Nothman for leading the team and overseeing the production of the report, and Lisa McCrummen for her vision, inspiration, and creative ideas—without which this report would have never come to be. We also thank those who reviewed the report and provided invaluable feedback in enhancing its quality, including Sheldon Alberts, Shaunna Morgan Siegers, and Kelly Frawley. We thank Lindsay McBlane for her assistance in map production, Katherine Lim for her help with French translations, and Jennifer Cerulli for assisting with photography needs. And, of course, we thank Lisa Holmes for her patience and attention to detail on the graphical design of the report.

The authors would also like to acknowledge Harvey Locke and the Nature Needs Half campaign for helping to promote and popularize the scientific rationale behind protecting half of our natural, wild lands. More can be found at www.natureneedshalf.org.