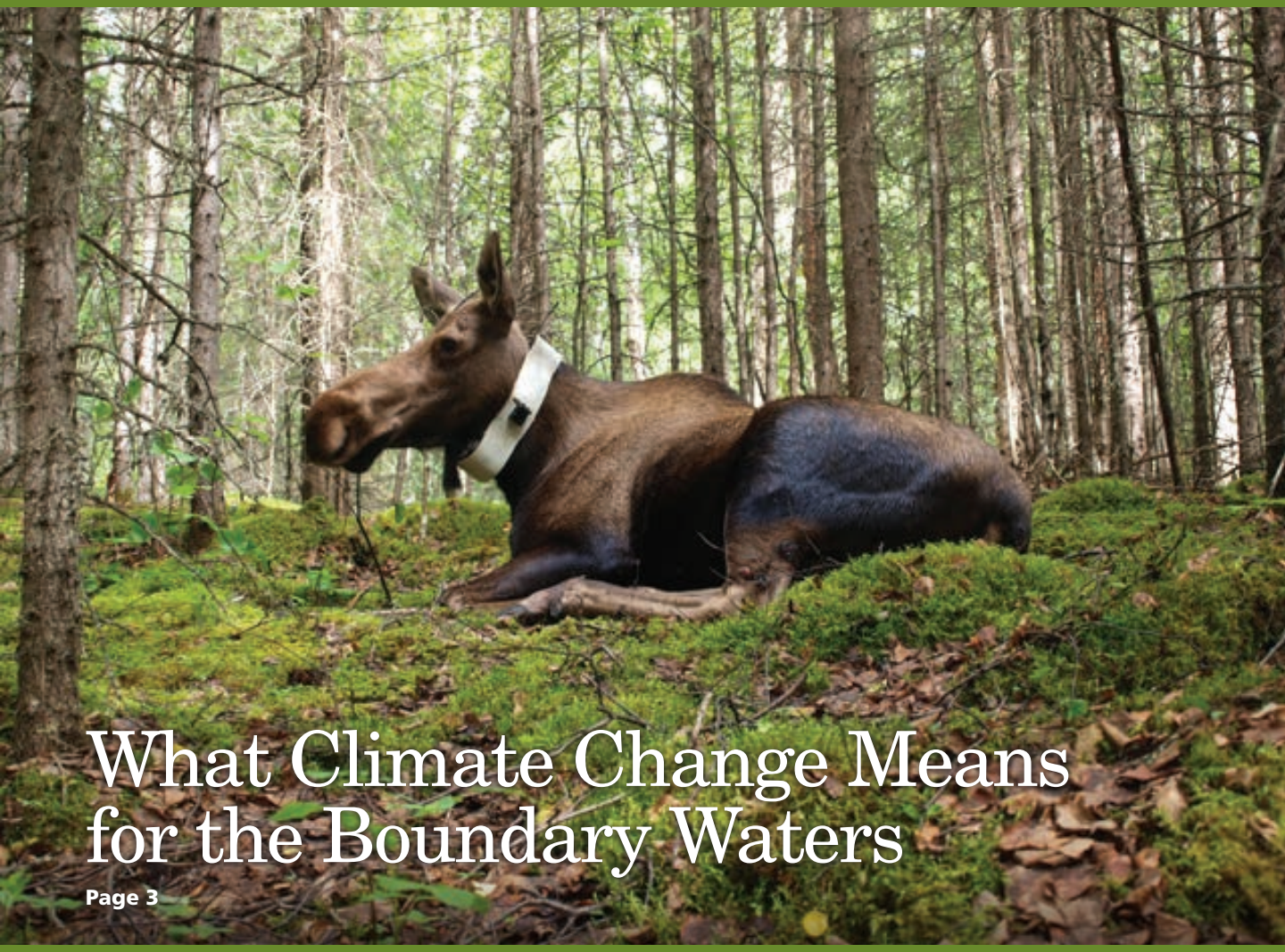
SUPPORTING THE PROTECTION OF QUETICO SUPERIOR CANOE COUNTRY

Summer 2016

Wilderness News



What Climate Change Means for the Boundary Waters

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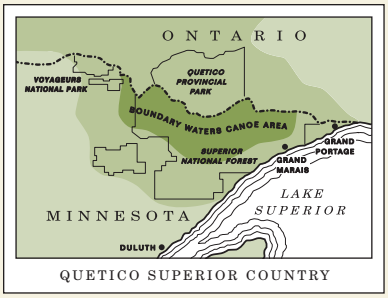

QUETICO SUPERIOR COUNTRY

The Quetico Superior Foundation, established in 1946, encourages and supports the protection of the wilderness, cultural and historical resources of the Quetico Superior canoe country and region.

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Evolving Changes are Inevitable

In this issue of *Wilderness News*, we take a look at the realities of a changing planet—changes that in some ways feel more pronounced in the Quetico-Superior Region. We learn how climate change is already affecting the border lakes canoe country, and how it is projected to continue doing so in coming decades. We get a status report on the region's birds and the Superior Hiking Trail, and learn about one man's personal take on climate change.

It can be easy to feel overwhelmed in the face of so much change and so many challenges, but two things stand out to me in this issue, warranting hope and optimism. First, there are bright spots. The Boundary Waters region could become a refuge for coldwater fish. The golden-winged warbler has found a sanctuary in northern Minnesota, and boreal birds are doing well compared to their cousins across the continent.

Even more striking, however, is the number of people involved in studying, understanding and volunteering for the benefit of the region. Scientists evaluate the changing landscape and animal populations so the public can make informed decisions. Volunteers build and maintain trails so outdoor enthusiasts can visit the places they love. Whether the issue is mining, climate change or land management, that kind of involvement is critical to preserving the land we all love.

I hope you'll continue to stay involved and informed about today's biggest issues, including mining on the edge of the Boundary Waters Canoe Area Wilderness. You can stay up to date with us between issues by following us online at www.wildernessnews.org.

Sincerely,

Jim Wyman
President, Quetico Superior Foundation

Cover: Photo by Ron Moen, PhD.

Part II: What Climate Change Means for the Boundary Waters Region

By Alissa Johnson

In the last issue of *Wilderness News*, we learned about Climate Generation: A Will Steger Legacy, which is reframing the way that people talk about the issue of climate change, incorporating not only the science but the potential solutions. In this issue, we learn about some of the ways that climate change is expected to affect the Boundary Waters region.

While there are still those who deny climate change, scientists from all types of institutions—from universities to state agencies—have been working to understand the effects of climate change in the Boundary Waters region. There are still many unknowns, but from their work, one thing is becoming clear: the central question is no longer if change will occur but to what degree. Changes are being seen in temperature, precipitation, and plant species, and changing climate conditions are also placing stressors on animal populations. Over the next several decades, the boreal forest so iconic to the northwoods could significantly change.

The epicenter of warming

In many ways, the Boundary Waters region lies at the heart of warming in Minnesota. Kenny Blumenfeld is a climatologist with Minnesota's State Climatology Office. He says that the locations typically vying to set records as the coldest are being affected the most. "From a really basic standpoint, warming in northern Minnesota is well underway and is actually warming faster… than any other part of the state," he said.

Winter temperatures and overnight lows are seeing the greatest amount of change. While the region has set some warm weather records during the summer, there is no trend showing an increase in the intensity of summer heat. Instead, winter has been warming at a rate that is ten times faster than summer—one degree Fahrenheit per decade compared to 1/10th of a degree.

"That, to me, is the number one change that we have seen because it's reducing the extreme cold conditions in winter so fast that areas in northern Minnesota that routinely went to negative forty, struggle to do it now. As an example, this last winter, no official National Weather Service Cooperative Observer station hit -40°F. That's pretty unusual," he said. As a public speaker, Blumenfeld has had audiences cheer at the idea of a warmer winter, but he points out that cold temperatures play an important role in the ecosystem.

"From a really basic standpoint, warming in northern Minnesota is well underway and is actually warming faster… than any other part of the state," – Kenny Blumenfeld

"Change is happening and we're seeing it. But it's something that you don't necessarily, as an individual, see from day to day or even from week to week." – Ron Moen

The Boundary Waters of Today:

A typical Quetico Provincial Park scene. As temperatures warm, scientists predict that the iconic boreal forest of the Boundary Waters Canoe Area Wilderness and surrounding region will be replaced by temperate forests and even oak savannah. Photo by Tim Eaton.

"It's true that winter, for the foreseeable future, will still get cold enough that it could kill a person if they're not prepared, but this eroding of the coldest temperatures causes secondary events that we're just starting to understand. There's a lot that we don't know—what that means for the forest ecosystem or anything depending on an integrative landscape. We're changing the settings," he said.

And temperatures aren't the only thing changing. According to Blumenfeld, northeastern Minnesota shows small signs of intermediate-term drying while the rest of the state grows wetter.

"In the area warming the fastest it's actually not getting any wetter so there is a net loss of water occurring… and that could be stressing some of the forest," Blumenfeld said. That could be important given the final trend that Blumenfeld noted: incidents of unprecedented rainfall. While things might tend to be drier, large rainfall events, like the one experienced in Duluth a few years ago, are getting slightly larger and happening more frequently.

"With the combination of the rapid temperature changes and the fact that precipitation isn't keeping up in northeastern Minnesota, the forests are going to be more susceptible to disturbance or damage by extreme weather events because there will be less structural hardiness. It's a time of pretty rapid change," Blumenfeld said.

"...the forests are going to be more susceptible to disturbance or damage by extreme weather events...It's a time of pretty rapid change," – Kenny Blumenfeld

Changing landscapes

Change is already being documented in the Boundary Waters Region. Lee Frelich is director of the University of Minnesota Center for Forest Ecology. He and several PhD students have been studying the Boundary Waters Canoe Area Wilderness region for about a decade, and Frelich is also developing a model that will project biomes in each part of the region, down to an extremely small scale. Based on their combined work,

The Boundary Waters of A Warmer Climate:

Lake, woodland and prairie vegetation in the Gneiss Outcrops Scientific and Natural Area in southern Minnesota offers an idea of what Voyageurs National Park and other parts of the Boundary Waters region might look like in 2070. Photo by Dave Hansen, University of Minnesota Agricultural Experiment Station.

Frelich expects the boreal forest—spruce, fir, birch, aspen and even jack pine and black spruce—to be invaded by temperate species like red maple, basswood and northern red oak over the next few decades.

"We're already seeing that happen in the seedling layer," Frelich said. Graduate student Dave Chaffin surveyed over 2,000 plots throughout the Boundary Waters and nearly all of them had red maple seedlings. Another graduate student, Nick Fisichelli, studied summer temperature conditions for boreal and temperate forest and found that, at cooler temperatures, spruce and fir seedlings grow faster than maple and oak. At warmer temperatures, maple and oak seedlings grow faster. As temperatures continue to climb, conditions will favor those temperate trees.

Frelich expects that temperate forest to last in eastern parts of the Boundary Waters with possible pockets of boreal forest. But based on the work of a third student, Nick Danz, who studied the boundary between forest and prairie, Frelich projects that the central and western parts of the wilderness area will eventually transition to oak savannah.

That variation primarily stems from temperature differences across the region. Graduate student Chaffin also distributed temperature sensors across the Boundary Waters and measured the temperature every two hours for two years. The eastern part of the wilderness is about 10 degrees cooler in summer than the area surrounding Ely, Minn., and is more conducive to temperate forests than the central and western regions. In the northeastern parts of the Boundary Waters, Frelich also expects to see variation between north and south facing slopes, where more solar radiation creates higher temperatures and causes more water to evaporate than on northern slopes. It's on those northern slopes that boreal forest could remain. It's also possible that in the middle and western parts of the wilderness there will be oak savannah on southern slopes and temperate forests on northern slopes.

Frelich expects to see a similar transformation in Quetico Provincial Park. "Quetico will pretty much be the same because it's pretty much at the same latitude as the Boundary Waters," he said.

Parasites and diseases related to warming temperatures have contributed to the decline of moose across the Boundary Waters region. Photo by Ron Moen, PhD.

Bobcats are already replacing threatened lynx in some areas. Photo by Gary Kramer/USFWS.

Impacts on animal and fish populations

Frelich is succinct when it comes to understanding what the change in forest will mean for animal populations. "When the boreal forest goes, the moose go with it, the lynx and probably the blackbacked woodpecker," he said, pointing out that lynx are already being replaced by bobcat in some areas. Bobcat are already being seen where lynx would typically thrive, and researchers have found that warming temperatures are a stressor for the region's declining moose population.

Ron Moen is an Associate Professor at the University of Minnesota Duluth and a Senior Research Associate at the Natural Resources Research Institute. He has studied both moose and Canada Lynx, among other mammals, and explained that northeastern Minnesota and Ontario are on the southern edge of the boreal forest. That can make animal populations more susceptible to change, and changes have occurred in moose and Canada Lynx that can be related to climate change. He emphasized, however, that there are many factors at play.

Most recently, for example, moose have garnered attention because of their declining numbers in the region. According to Moen, warming temperatures have placed stressors on the species, but parasites, habitat changes and predation all play a role as well—and the decline is still being studied. However, for adult moose in particular, parasites and diseases related to warming temperatures have contributed to the decline. And a study conducted in conjunction with the Minnesota Zoo showed the respiration rate of moose increases at about 68 degrees Fahrenheit for the same reason that a dog or sheep might pant: moose don't sweat and need to lose heat. That can have significant implications, causing animals to forage at night rather than during the day, which is a less efficient way of eating.

The takeaway, according to Moen, is that, "Change is happening and we're seeing it. But it's something that you don't necessarily, as an individual, see from day to day or even from week to week."

Cold water fish are also showing signs of change, though in an interesting twist, lakes in the Boundary Waters could provide a refuge for such species. Peter Jacobson is a research scientist with the Minnesota Department of Natural Resources. He confirmed that some cold water fish have been on the decline since the early 1980s, most notably Cisco, a cold water fish found in 650 lakes across the state.

"We think climate change is a big part of that," he said. Yet the further north you go, he noted, and the deeper and clearer the lake, the better things are. "We used those properties to identify 176 of those 650 lakes that are probably going to be refuges from climate change."

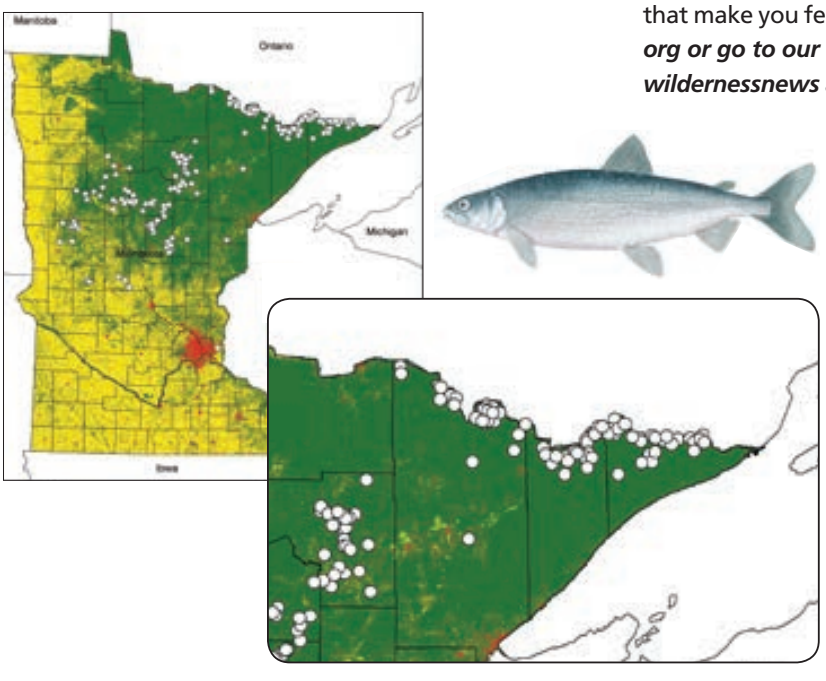
In those 176 lakes, cold water fish are going to persist, and some of those lakes are in the Boundary Waters. "It's critical that we protect those lakes and ensure that they are going to be refuges from climate change in the future, protecting their water quality and for lakes in the northern part of the state, keeping watersheds forested," he said.

Quaking aspen, a distinctive feature of today's boreal forest. Photo by Steven Katovich, USDA Forest Service, Bugwood.org.

Making sense of the changes

Uncovering the changes that are resulting from climate change is one thing. Figuring out what to do with the information is another. In the next issue of *Wilderness News,* we'll look at some of the things people are doing to impact and prepare for climate change.

But there is an emotional component, too. These impacts change the nature of a landscape beloved for being a boreal forest, with moose, lynx, and other northwoods animals. When you read about the changes, how does that make you feel? ***Email us at editor@wildernessnews.org or go to our facebook page at www.facebook.com/wildernessnews and share your view.***



"It's critical that we protect those lakes and ensure that they are going to be refuges from climate change in the future, protecting their water quality and for lakes in the northern part of the state, keeping watersheds forested," – Peter Jacobson

Coldwater fish like Cisco have been on the decline since the 1980s, due in large part to climate change. Found in 650 lakes across Minnesota, it is in the Boundary Waters region that the deep, clear lakes may provide refuge for the fish in coming decades. Images courtesy Peter Jacobson, MNDNR Fisheries Research. Fish illustration above ©MNDNR C. Iverson.

Status Report: Border Country Birds

By Greg Seitz

The loon's famous song, echoing across wilderness lakes, makes solitude audible. It simply sounds like wilderness. The solitary birds are living emblems of the Quetico-Superior Region—along with white pines, wild rice, and moose.

Dr. Muir Eaton, Professor at Drake University. Photo by Dr. David Biesboer, Professor of Plant Biology, Director, Itasca Biological Station and Laboratories.

Many other bird species also find the habitat they need to breed amid the forests, lakes, rivers, and wetlands of the Boundary Waters, giving unique voice to the wild landscape. Here, a tongue of Canada's boreal forest creates ideal conditions for an array of bird species—for a few months each year. Most birds live in the region during the short summer when it bursts with solar energy, staying only long enough to nest, raise chicks, and bulk up to fly far to the south in the fall.

"It pays to undergo this long-distance migration to get to a place where there's a massive abundance of food for a short seasonal time," says Dr. Muir Eaton, an ornithologist with Drake University and the University of Minnesota's Itasca Research Station.

Swainson's thrushes, white-throated sparrows, ring-necked ducks, chickadees, whiskey jacks, veeries, all these and more are interwoven with spruce and pines, flies and flowers, and each other. Ornithologists estimate that between 3 and 5 billion birds live in the boreal forest during breeding season.

The border lakes region is a refuge for a lot of different ducks, many of which remain hidden to visitors much of the time. "They breed on small lakes in the woods and come out to the bigger lakes to get ready for migration," Eaton says.

With so much food available and so many species seeking a place to propagate, border country birds specialize in eating different foods, nesting in different types of foliage, migrating at different times, courting and breeding differently, and singing different songs. Eaton points to shorebird species that have legs and beaks of varying lengths, perfect to pluck insects out of different depths of sand and water. Nothing goes unused.

White-throated sparrow
Photo by Simon Pierre Barrette, Wikimedia Commons (CC 2.0)

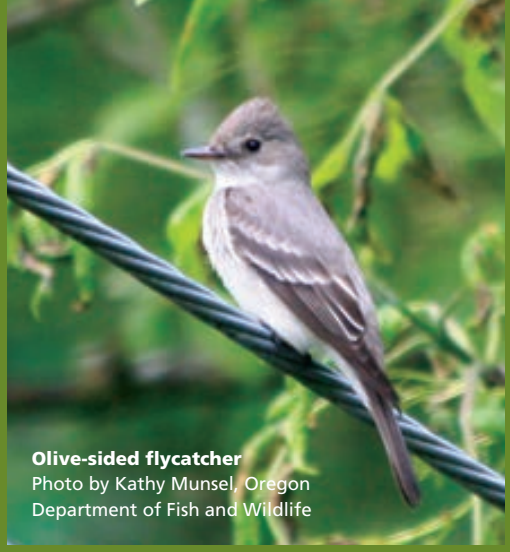
Making mosaics for warblers

The rich gathering of avian life has the strength of numbers and the fragility of specialization. Wiping out a particular type of habitat can decimate a species. The golden-winged warbler is an example; its numbers having plummeted as forest-edge lands have disappeared over recent decades. Farmers have plowed fields, forest fires have been extinguished, houses have been built, logging has dwindled.

This mish-mash of changes has slashed the amount of land available for the golden-winged warbler. All but gone from Appalachia, its overall numbers down more than 60 percent during the past 50 years, the bird may soon be listed on the federal Endangered Species List.

Golden-winged warbler
Photo by Rachel Vallender

White-winged scoter*
Photo by Mark Bertram, USFWS



Olive-sided flycatcher
Photo by Kathy Munsel, Oregon Department of Fish and Wildlife

American black duck*
Photo courtesy USFWS

Cape may warbler*
Photo by Bill Majoros

14 species that breed in boreal forest and are on the NABCI Watch List:

Bicknell's thrush
Whooping crane
Hudsonian godwit
Short-billed dowitcher
Surf scoter
Canada warbler*
Cape May warbler*
Connecticut warbler*
Lesser yellowlegs*
White-winged scoter*
American black duck*
Black-billed cuckoo*
Olive-sided flycatcher*
Evening grosbeak*

** Range includes Voyageurs National Park, Superior National Forest, and Quetico Provincial Park.*

Evening grosbeak*
Photo courtesy USFWS

Lesser yellowlegs*
Photo by Wolfgang Wander

Connecticut warbler*
Photo by Matt Tillett

It has found a refuge in northern Minnesota, where half its total population is now believed to breed. In one square-mile of forest in Itasca County, biologists counted 36 singing males this summer, according to the *Duluth News Tribune.*

"That's the highest concentration of golden-winged warblers anywhere that we know of," Jerry Niemi of the Natural Resources Research Institute at the University of Minnesota Duluth told the newspaper ('Unique forestry method created perfect habitat for golden-winged warbler,' John Myers, June 7, 2016).

The bird's peculiarity about where it lives and what it eats is why it is thriving in this swath of north woods. While it makes its nests and raises its young on open ground, it spends the later part of the season in nearby mature woods. This patchwork has been crafted by biologists, logging companies, and conservationists in recent years, resulting in golden-winged haven.

Beating bird benchmarks

Boreal birds are doing well compared to cousins from across the continent. While 37 percent of bird species in North America are "at risk of extinction without significant conservation action," most of those call the ocean, coasts, and tropical forests home, according to the North American Bird Conservation Initiative's (NABCI) State of North America's Birds 2016 report.

To produce the report, the organization undertook a first-ever assessment of all 1,154 bird species native to Canada, the continental United States, and Mexico. It found 432 that are at severe risk of vanishing.

In the continent's relatively intact boreal forest, most threatened bird species are imperiled because of conditions on the other end of their migration, in the forests of Latin America and South America. Some of the 14 boreal species that are on the NABCI Watch List are the black-billed cuckoo, Canada warbler, evening grosbeak, American black duck, lesser yellowlegs, and the surf and white-winged scoters.

"Compared to the prairie or eastern forests, which were pretty much mowed down in the last century, the boreal forest probably has been the least attacked over history," Eaton says. "It might be an ecosystem that has fared pretty well." Eaton teaches a field class at the University of Minnesota's Itasca Research Station each summer, and small-scale population monitoring is part of the program. He says they haven't seen any declines in any bird species.

"When the habitat is there, those populations do well," he says. The millions of acres of mostly naturally-functioning boreal ecosystem on the Minnesota-Ontario border are valuable for canoeing, camping, fishing, and for spruce grouse, three-toed woodpeckers, and goshawks.

Critical questions

The biggest threat to birds might be our own lack of knowledge. Even after centuries of study, much remains unknown about many species. "There is a lot of basic natural history we don't know," Eaton says about many species of birds. "Where do they build their nests? What is their energy budget when they have young in their nests? We have glimpses of a lot of pieces of the biology of a lot of birds, but we're far from knowing comprehensively about their biology."

For example, birds that nest in tree cavities, such as wood ducks and bluebirds, are pretty easy to study, because they will often use artificial nest boxes. But birds that nest 30 feet up in a pine tree are a different matter. With habitat loss the culprit in most bird population declines, Eaton says we need to better understand how deforestation and other changes affects many species.

While ornithologists perform their researches, anybody with a birdfeeder can help the feathered cause by contributing to citizen science efforts. Cornell University's programs are some of the best.

"Cornell has been instrumental in trying to garner good scientific info out of the public," Eaton says. "It's clear that there are a lot of people out there that can identify birds and record data, and they have turned a lot of data into usable information about migration, arrival times, how they are moving through the landscapes."

Cornell's FeederWatch initiative asks people to simply count the birds that show up to their feeders from November to April and share the data. Based on thousands of observations, they can accurately estimate how many birds there are and where they are, week by week. Visit ***www.feederwatch.org*** *to learn more and participate.*

Canada warbler*
Photo by Jeremy Meyer

Black-billed cuckoo*
Photo by Wolfgang Wander

* *Species on the NABCI Watch List whose range includes Voyageurs National Park, Superior National Forest, and Quetico Provincial Park.*

Bicknell's thrush
Photo by Phillip Kenny/Wikimedia Commons (CC 2.0)

Whooping crane
Photo by Ryan Hagerty/USFWS

Surf scoter
Photo by Alan D. Wilson
NaturesPicsOnline

Short-billed dowitcher
Photo by Dick Daniels
http://carolinabirds.org

Hudsonian godwit
Photo by Francesco Veronesi/
Wikimedia Commons (CC 2.0)

Hiking near Carlton's Peak on the Superior Hiking Trail. Photo courtesy Superior Hiking Trail Association.

THREE DECADES OF SUPERIOR HIKING

By Greg Seitz

This summer, thirty years after a pair of trail-builders first started flagging a hiking route along the ridges overlooking Lake Superior on Minnesota's North Shore, the Superior Hiking Trail will be finished—mostly.

The final section of the trail, connecting it to the Wisconsin border southeast of Duluth, should be completed by Labor Day. Hikers will then be able to travel from that point all the way to the Canadian border on the trail that has been called one of the best in America. But the work is never done. Hundreds of volunteers will continue to put in thousands of hours each year keeping the trail in good condition.

"We have job security for our volunteers," says Jo Swanson, outreach coordinator for the Superior Hiking Trail, the organization which maintains the trail. "Every year, we have to clear the trail all over again."

In the spring, trail workers remove trees and clear brush that blocks the path. All summer, they repair and replace bridges, clean and maintain campsites, and keep trailheads in good shape. In 2015, about 300 volunteers logged 6,000 hours of trail maintenance.

Those hours come in a variety of ways, including several trail-clearing weekends each summer, when groups of volunteers, including some with chainsaws, ensure the whole path is passable. Volunteers have also adopted each of the trail's 95 campsites, as well as all its trailheads. These individuals visit a couple times a year to make sure their assigned areas are up to the Superior's high standards, many of them traveling from the Twin Cities.

"It's amazing to consider the hours people put in on the trail, but also the time people take out of their lives to drive up," Swanson says. "Not only do that many people love the trail, but love it enough to keep it going."

There is always more to do, and Superior Hiking Trail Association executive director Gayle Coyle says the increase of extreme rainfall events resulting from climate change is making the job even more difficult.

"We lose more stream banks to erosion, and our wooden handset bridges which we used to be able to build with a maintenance supervisor and volunteers, are no longer good enough in many cases. We have to move to longer, more engineered bridges, which are more expensive and can't be done with volunteers."

In June 2012, record-setting rains hit the North Shore, including the Superior Hiking Trail. Flooding of Lake Superior tributaries between Duluth and Gooseberry State Park changed river channels in such a way that the rivers will never be the same.

"The waters were so high and so fast that as they went around outside curves, they dug into the bank, and then deposited stone on the inside of the curves.

Above: A boardwalk traverses a beaver pond on the Superior Hiking Trail. Photo by Greg Seitz. At right: Volunteers use tools called McLeods to clear the tread on the Superior Hiking Trail. Photo by Mark VanHornweder, courtesy Superior Hiking Trail Association.

Above: Half the trail's life ago, *Backpacker* magazine said it had the best signage of any trail in the United States. Photo by Greg Seitz. At right: admiring an autumn view on the Superior Hiking Trail near Finland. Photo by Dave Noll.

Now whenever you have a minor rain event, the outside bank is being eroded even more, because the inner shoreline is covered in rock."

With this new reality and 300 miles of trail to maintain, SHTA always needs more volunteers. All the work pays off for the approximately 25,000 people who travel the Superior Hiking Trail every year. While a few hundred folks hike the whole thing, the Superior Hiking Trail has always been designed as ideal for day hikes, meaning it's a popular destination for many, no matter their experience or strength.

"All ages and backgrounds come to enjoy the trail," Swanson says. "It's fantastic for day hikes, and we have a lot of opportunities to go explore for an hour. But then we have people heading out for a thru hike for two or three weeks."

With two more miles of the trail in the works, there will be that many more options for hikers. The new and last section planned will go from Jay Cooke State Park to the Wisconsin border. An extension of the trail through Duluth to Jay Cooke was completed between 2004 and 2007.

When the trail was first built in the late 1980s and early 1990s, it blazed a path through wild forests, following the flags of Tom Peterson of the Minnesota Department of Natural Resources and Greg Wester of the Minnesota Conservation Corps. They approached the task by identifying stream crossings and vistas and other key points, and then figuring out how to connect the dots. The pair recently recalled the adventurous job in a story by Sam Cook in the *Duluth News Tribune.* "We'd explore for three or four days at a time," Wester said. "Some areas, you knew there were going to be overlooks. You got there, and it was as spectacular as you thought."

Most of the trail crosses lands owned by the U.S. Forest Service, the state of Minnesota, and local counties and municipalities, but it also includes more than 60 pieces of private property. To cross Duluth, trail planners focused only on public lands, which is surprisingly abundant in the city.

"Duluth always had trails along their creeks that went from the top of the ridge to the lake," Coyle says. "The Superior Hiking Trail is now incorporating and connecting those city trails."

There are no backcountry campsites in the Duluth section, so a true "thru-hike" is usually the 255 miles from the northern edge of the city all the way to Hovland, MN, a couple miles short of the Canadian border. There it connects to the Border Route Trail, which traverses the eastern section of the Boundary Waters Canoe Area Wilderness, and then to the Kekekabic Trail.

Ultimately, it is hoped that the national North Country National Scenic Trail will bypass 100 miles of bogs in northern Minnesota, which were designated as its official route in the 1980s, and instead follow the Superior, Border Route and Kekekabic trails. Federal legislation is required for such a re-route.

Wherever it wanders, from the rocky shores of Lake Superior to the peaks and valleys of the Sawtooth Mountains, the trail passes through some amazing terrain. It crosses rivers rushing down toward the big lake, follows rocky ridges through stands of aspen and pine, and even dips down to the very edge of the lake for two miles, where hikers can walk next to earth's largest freshwater lake in the world, on one of the best trails in the world.

Find out more at http://www.shta.org

Climate Change and the Disassembly of the North Woods

In an excerpt from John Pastor's new book, *What Should a Clever Moose Eat? Natural History, Ecology, and the North Woods,* the author examines the impact of climate change on the North Woods and the personal responsibility that comes with it. Copyright © 2016 John Pastor. Reproduced by permission of Island Press, Washington, D.C.

The North Woods often seem eternal to people who live or travel there. This is especially so in the old growth forests of the Quetico-Superior and Adirondack Wildernesses. In 1954, William Chapman White wrote in his classic book Adirondack Country, "As a man tramples the woods to the lake, he knows he will find pines and lilies, blue heron and golden shiners, shadows on the rocks, and the glint of light on the waters, just as they were in the summer of 1354, as they will be in 2054 and beyond."

Yes, we might see more or less the same scene if we time-traveled back to 1354, but it is an open question whether we will be able to see these forests in 2054. In 1354, the carbon dioxide concentration of the atmosphere was a mere 280 parts per million. Today, the carbon dioxide concentration of the atmosphere is 400 parts per million and it may be well above 450 parts per million by 2054. Carbon dioxide traps heat. As its atmospheric concentration is increasing, the temperature of the earth is rising rapidly, especially in northern regions.

At the end of the Ice Ages, the North Woods was not an intact biome sitting south of the ice sheet. Rather, starting 6,000 years ago it gradually assembled itself as the species we know today invaded the barren landscape, one by one and from different directions, as the ice sheet retreated. With further warming, the North Woods will not simply shift northward but instead it will very likely disassemble as species contract their southern and western boundaries at different rates and in different directions and beginning at different times. New species combinations will replace the North Woods in its current location.

As the earth warms, spruce and fir will invade the regions that are currently tundra. Much of the year, the tundra is now a white expanse of snow and a nearly perfect reflector of the sun's radiation. This white expanse cools the earth. In contrast, the dark conifers to the south of the tundra absorb sunlight and convert it into heat. As the dark conifers invade the white tundra, less sunlight will be reflected and more of the sun's warmth will be absorbed. The energy balance of the earth will then shift toward warmer falls, winters, and springs. Warming in northern latitudes will not simply produce a shift in these biomes; the shift in species' ranges will also feed back and exacerbate the warming.

Most computer models predict the near disappearance of the North Woods in its current location if temperatures increase as little as 3 or 4 degrees F and especially if the warming is accompanied by droughts in midcontinent areas. These predictions are already coming to pass, as spruce and fir growth are decreasing and maple growth is increasing in northern Minnesota. If we continue to warm the climate as we have been doing, the different migrations of species may cause the North Woods to become confined to isolated pockets in Canada sometime during my grandchildren's, and certainly during my great-grandchildren's, lifetimes.

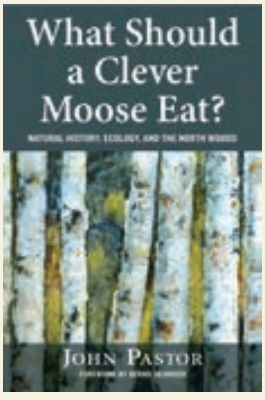
So much of how we define ourselves as a people depends on the natural history of the landscapes we live in and the organisms we live with. Arizonans are the people of the Sonoran Desert; Vermonters are the people of sugar maples and maple syrup; Minnesotans are the people of big pines, wolves, moose, and the wails of loons. Who will we be if we lose the landscapes and organisms that define us? What will our grandchildren and great-grandchildren think of us when they learn that, by burning fossil fuels, we deprived them of the opportunity to also be the people of white pine, moose, and loons, even though we knew what the consequences would be? Can any of us look our grandchildren and great-grandchildren in the eye and try to explain this without shame?

Life goes on in the face of extinction of species and biomes, but there is a difference between extinctions that have happened in the geological past and extinctions that we knowingly cause but refuse to take responsibility for. The first is part of the natural history of life on this planet; the second has serious moral implications for how we interact with the rest of life on Earth.

To preserve the North Woods for the future, we will need to preserve the climate of the entire planet as well as current wilderness areas such as Quetico-Superior. If we do not, new assemblages of species will form and the North Woods as an intact ecosystem will probably almost, if not entirely, disappear. We are on the cusp of whether we want to try to stop the worst of this.

We are now responsible for the future of the North Woods.

To order Pastor's book or read more essays about natural history, ecology, and the North Woods, please visit http://www.theclevermoose.com/. Use the code 4moose when ordering the book from Island Press and receive a 20% discount.



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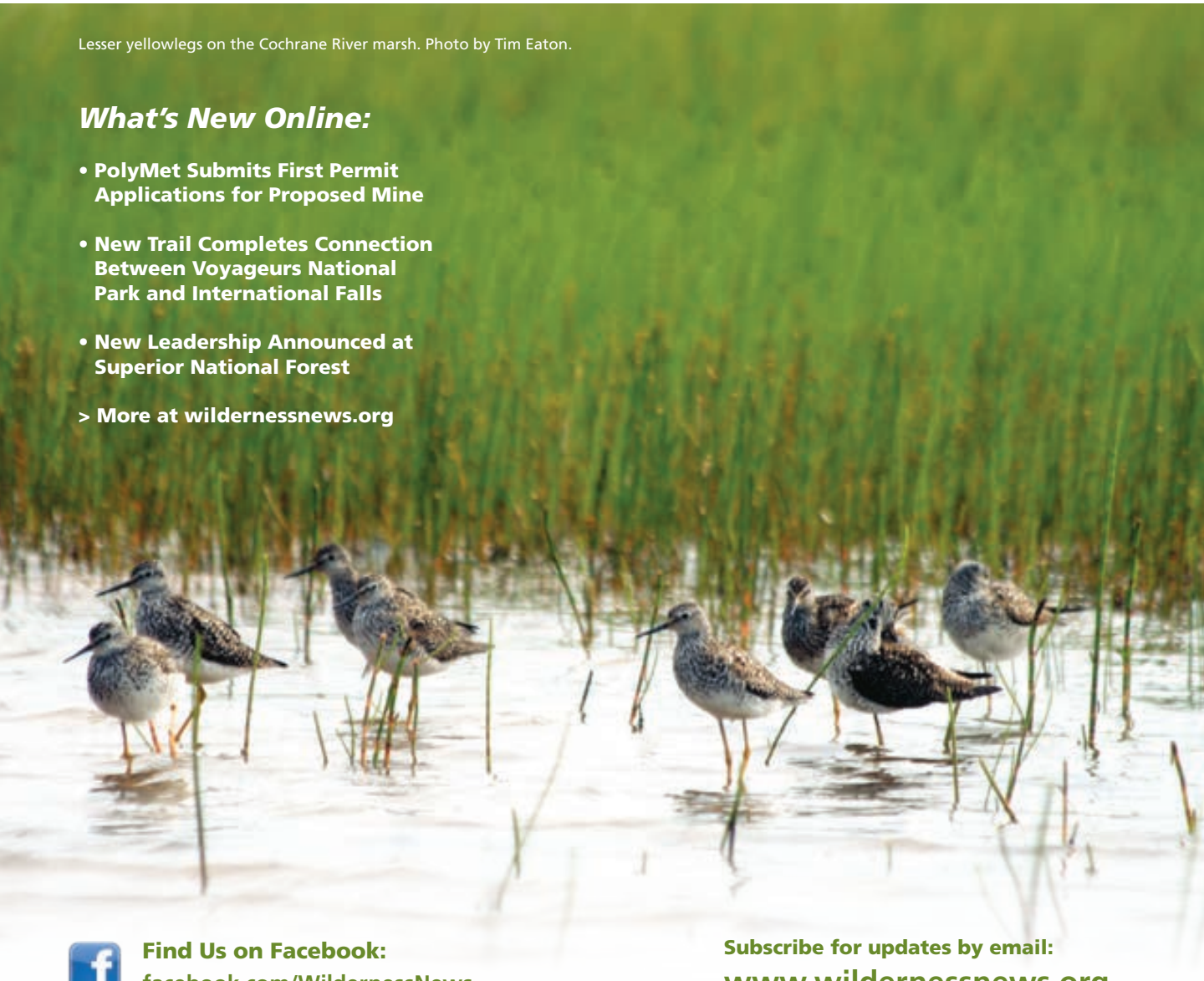

Lesser yellowlegs on the Cochrane River marsh. Photo by Tim Eaton.

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