Stories from Minnesota's Nongame Wildlife Program

SCIENCE | INSIGHTS | PEOPLE

DEPARTMENT OF NATURAL RESOURCES

DEPARTMENT OF NATURAL RESOURCES

Dedicated to you, the reader, together with all those working to conserve the wildlife that relies on Minnesota's landscapes. Here's to the many good stories yet to be told.

Front cover left: Canada lynx
Front cover center: Northern goshawk, photo by Michael Furtman
Front cover right: Blanding's turtle
Back cover left: Eastern timber rattlesnake
Back cover center: Green frog
Back cover right: Nelson's sparrow

Photos on pages 9,10,19,53,61,69 and 93 were submitted.
Except where deemed essential, common names of plants and animals have been used rather than scientific names. Readers are welcome to refer to the Minnesota Department of Natural Resources Rare Species Guide (see list of Resources at the end of each story).

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Western meadowlark
Photo by Bob Dunlap, MN DNR

Preface

Welcome to this series of stories about the Minnesota Department of Natural Resources (MN DNR) Nongame Wildlife Program; we're glad you're here.

This project originated with a desire to share a more complete picture of our work with the people who have invested in and who care about sustaining Minnesota's biodiversity.

Of course, the program is routinely accountable to its grantors. On the front end, we provide funding agencies and entities with proposals for projects that fit their often narrowly-defined criteria. These proposals identify needs, outline goals and detail project budgets. On the back end (and sometimes at periodic intervals within a funding cycle) we provide reports that summarize outcomes. All well and good.

But we recognized a missed opportunity. There was a lot of really interesting work being done, and significant outcomes, that weren't being shared with a broader audience. We knew that just getting the grant reports out there and making them available to the public was not enough. Some of this work happens over long time periods—decades—and is not well conveyed within the bookends of a one or three-year grant cycle. We needed something that offered context and interpretation that would make the specialized aspects of the work more meaningful to those who were unfamiliar: something that didn't exclude people by being too "inside baseball." And there were things we felt were essential that you'd rarely, if ever, find in a grant report, that have to do with the actual scope of the program, the nature of the work and the people who do it. Plus, there were just so many cool stories going untold that we thought you'd like to hear.

So, here we are, with a series of seven stories in response to that opportunity.

An advisory of sorts is in order. You'll find that the stories don't skate over the technical concepts and science that underlie this work. Rather, they relish these aspects and dig in, with the aim of deeper understanding. We trust that you're up for it and interested. Over the course of the stories you will get a glimpse of the nitty-gritty work of the Nongame Wildlife Program; the places and spaces where it occurs; the methods and strategies; the modeling, collection and analysis of data that guides priorities; the constant stretching of too-thin resources for the best outcomes; the efforts to understand and meet the unique needs of wildlife species to help populations persist. At the heart of each of these, you will meet individual people—professional program staff, key partners from other agencies, volunteers—all personally dedicated to the mission of sustaining a diversity of wildlife in Minnesota.

By the time you read these words, the featured projects and people will have moved forward in myriad ways. Certainly, tallies will have shifted one way or another in numbers of acres restored, populations of species, trends. For these, we encourage you to tap into the many regularly updated reports and plans provided on the Program's webpage at **mndnr.gov/nongame**.

Nongame Wildlife Program Leader Cynthia Osmundson* Photo by MN DNR

*In the weeks between finalizing the content of this publication and printing, Cynthia Osmundson retired, and Kristin Hall was appointed as the new Nongame Wildlife Program Supervisor.

At their essence, these stories remain current. What has not, will not, move on with the passing of time is the complexity of the Nongame Wildlife Program's efforts and the vital importance of the work. Today and every day, there are breeding populations of species trying to live out their existence in the state's wetlands, lakes, rivers, prairies and forests. What once happened naturally now requires our active, science-based management.

We invite you to be engaged as we navigate the future. As these stories relate, there are many challenges, but also many rewards. Public support is not only needed, it's essential. People are sometimes surprised to learn that the state's Nongame Wildlife Program relies for its operating budget on donations from the public, which are then used as leverage for grant funds. Each year, any direct donations as well as contributions to the "Loon Line" on the state's tax forms make the program eligible to receive matching funds from the Critical Habitat License Plate program. Combined, these are then used as the required state match for federal dollars. The downside of this for the program is a lack of predictability in terms of planning and budget; the upside is that, with every donation, we have a measure of how much the people of Minnesota value nongame wildlife within the larger picture of natural resources in Minnesota. When we are doing this work, whether from an office or in the field, we know that we are representing the interests of citizens. Volunteering is another great way to support the program, as our Community Science Coordinator, Mags Edwards, would be the first to say. The voices of citizens are also critical as our state and communities set priorities and try to find a balance in how we manage the state's natural resources.

You might be a faithful donor, a knowledgeable volunteer, a collaborator in our work, a longtime advocate for biodiversity. You might know of us only through the Eagle Cam; or this might be your first introduction to the Nongame Wildlife Program. Regardless, we hope this series will enrich your understanding of the work being done, and—especially—the work that remains to be done.

For my part, as the Nongame Wildlife Program Leader, I hope there might be something in one of these stories to inspire a young person to pursue a career in biodiversity research and conservation of nongame wildlife. We need that next generation to someday step into the boots of the professionals featured in these pages. I also hope that everyone who comes across these stories feels like they have a personal role to play in the future: a future of continued learning, good stewardship, and enjoyment of the remarkable creatures that inhabit Minnesota's landscapes. Sometimes it can feel like everyone is an expert, that there is no room for an absolute novice who is maybe putting up their first bird feeder or has never really noticed—much less identified—the song of a frog. I am telling you, there is room for you.

Reading these stories, you might find it curious that the program pays so much attention to things other than wildlife, whether it be clearing cedars from a rocky bluff, maintaining forest cover around shallow, temporary wetlands, or tracking diversity of vegetation in native prairies. But you can't focus on wildlife without focusing on the entire ecosystems that support their existence. As Aldo Leopold famously said, "...to keep every cog and wheel is the first rule of intelligent tinkering." For the Nongame Wildlife Program, that also means remembering the less charismatic wildlife species—the beetles and butterflies, the frogs and snakes and bats and voles, each of which have a role to play in a healthy ecosystem.

Thank you to the people whose faces and voices you'll find in these pages, who are just a sampling of the community of highly-skilled professionals, partners, landowners and volunteers (past and present) whose insights and passion make this program tick. Year after year, they commit themselves to the strong science and solid data that is needed to make a difference for rare wildlife and Species in Greatest Conservation Need that we might otherwise lose.

So much happens behind the scenes. You might only see an empty truck parked on the side of a remote gravel road, but they're out there in all corners of the state and in all kinds of weather. They're restoring wood turtle nesting habitat and protecting hatchlings from predation, protecting critical nesting sites for piping plovers on Lake of the Woods, studying golden eagle wintering habitats, running nets through little prairie streams in hopes of finding Topeka shiners, and trying out new scientific techniques that detect the presence of rare species from traces of DNA in waterways. They're also poring over data, revising computer models, and planning the next best steps to protect the state's nongame wildlife; wildlife whose habits and habitats they have carefully studied, and—in many cases—that they have looked in the eye.

It's a privilege to share their stories with you.

Remember that Loon Line! .....

IT'S BACK!

THE NONGAME WILDLIFE PROGRAM RETOOLS, REBOOTS STATEWIDE FROG AND TOAD CALLING SURVEY

Trembling shallows music,
the green frog sings
explosions
plucked in ragged rhythm
on deadened banjo strings

L. Allmann

Work begins at sunset, if the conditions are right. Snow, fog or a light drizzle are fine, full-on rain is not. Ideally, the air is calm, but a breeze of up to 12 mph—enough to gently stir the leaves on trees—is also acceptable. If your route is located in western Minnesota's Great Plains region, winds could be a bit higher, since wind moving through grasses is relatively quiet. If conditions aren't right, just wait for another night.

Every year from 1994 to 2017, volunteers serving as community scientists for the Minnesota Frog and Toad Calling Survey documented species heard along their assigned road routes across the state. As per the protocol, each route was run three times annually (early spring, late spring, and summer) to cover the progression of calling periods associated with different species throughout their breeding seasons. Identification was by sound alone. People who devoted their time to the survey—some for decades—attuned their own lives to this ancient natural calendar.

Green frog

Maggie (left) and Beth (right)

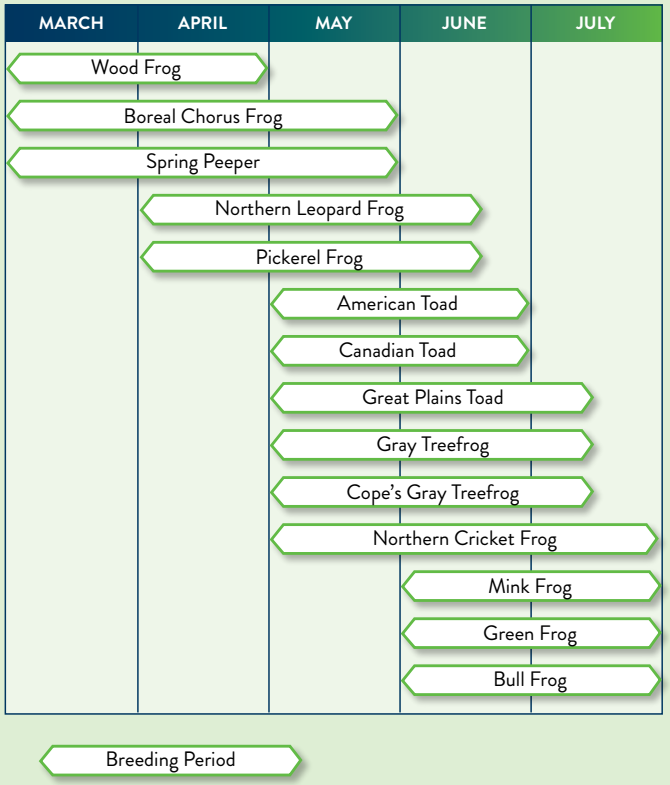
"My two oldest daughters, Maggie and Beth, would go with me," says Kathy Fillmore, whose route was in a rural area of northwest Minnesota's Marshall County. "They were three and five years old when we started. They loved it. I'd grab a snack for them, some blankets and pillows. As it got dark, we'd get in the van and head out of town. At each of the ten stops on our route, we'd listen. I'd ask, 'Okay, what species do we hear? Is it a few or many?' They weren't just along for the ride. They got very good at it. We did it all through their high school years, so they basically grew up with it."

In another corner of the state, Connie and Greg Olson's route was near Hoyt Lakes in St. Louis County, where they have a little lake place. "We'd schedule our time up there to correspond with the three windows of the count," says Greg, "then watch the weather channel once we got there, to pick the night we'd go out. The first one in spring came shortly after the water was open, basically just warm enough for the frogs to thaw out. The last one, in summer, we would have a long wait for dusk. It seemed to take forever for the sun to go down."

As many as 170 survey volunteers were doing the same: waiting for dusk, often solo or in pairs. A route might take two hours to complete. Each time, the steps were the same. Driving along rural roads to reach your starting point. Stopping. Shutting off the engine. Listening for the requisite five minutes. Progressing to the next stop, and the next, until all ten are complete. Documenting species heard on a standardized datasheet, with codes for estimates of abundance. Afterwards, submitting the data to the MN DNR Nongame Wildlife Program.

Breeding Timeline

Calls from multiple species are often layered over each other. Some calls are unmistakable (a chorus frog's ascending ripple, like a fingernail run across the teeth of a comb) while others are notoriously hard to distinguish unless heard side by side (an eastern gray treefrog from a Cope's gray treefrog).



Modified from Hine, R. 1982. Creatures of the Night. Wisconsin Readers Rev. 29(1): 21 – 2.

Chorus frog, an early spring caller
Photo by Carol Hall, MN DNR

For this to work, participants had to become familiar with a new language—actually, a dozen languages. Each volunteer was given a CD with recordings of the vocalizations of Minnesota's 14 species of frogs and toads, to learn the calls and to refresh their memories in subsequent years. An online quiz affirmed each volunteer's ability to accurately identify calls by species. Compared to learning the songs of the more than 300 bird species in the state, it might be considered a relative cakewalk. But there are notable challenges, not the least of which is that calls from multiple species are often layered over each other, sometimes at decibels loud enough to make your ears ring. Some calls are unmistakable (a chorus frog's ascending ripple, like a fingernail run across the teeth of a comb) while others are notoriously hard to distinguish unless heard side by side (an eastern gray treefrog from a Cope's gray treefrog).

Most species don't range statewide, so the actual number of species a volunteer might expect to hear on a given outing was more limited—which is not to say that they wouldn't encounter the unexpected. It was a volunteer from the Frog and Toad Calling Survey who, in 2004, reported hearing cricket frogs along a route in Winona County. It was the first record of the species in the county and, at the time, was one of only three verified records statewide since 1980 for the cricket frog, a state listed endangered species in Minnesota.

When you talk to these volunteer community scientists, they'll tell you that doing the survey was something they looked forward to and enjoyed. They will also tell you that their motivation was rooted in the importance of the task at hand. They knew they were part of something bigger, something with the potential to help perpetuate those voices in the night and to alert us all to issues affecting human communities as well.

Earl Woolsey felt guilty about buying a newer truck back in 2004. "I don't know, it seemed kind of expensive. I thought, I'm going to make sure I get some use out of this truck to volunteer, to do some good with it." He lived just across the Red River in Grand Forks, North Dakota, and signed up for the Minnesota Frog and Toad Calling Survey after finding the project on the MN DNR website. Thirteen years after he began, Earl and the truck were both still running, completing his survey routes across Douglas and Norman counties and sending in the data. As time passed, he grew increasingly curious about the degree to which climate change would shift the borderlines of the state's biomes—in his region, where prairie meets forest—and with them, the habitats and distribution of species like the treefrogs and American toads he had been documenting. "Different biomes favor different species," he says, "so you have to wonder what will happen as those borders move."

Earl Woolsey, survey volunteer

"When I first started, finding these sounds in nature was really delightful. It was a surprise to realize that they'd always been there, but I'd just never really separated them from the background noise. Then, after learning their calls, I couldn't ***not*** *hear them. I'd be watching TV and identifying the frog species calling on the X-Files!"*

EARL WOOLSEY, Survey Volunteer

Connie and Greg Olson, survey volunteers

Says Connie Olson, "Greg and I grew up in the time of Rachel Carson. We're aware that frogs and toads are a way to measure all kinds of changes in the environment, be they for the better or, mostly, for the worse. So, when we read about the survey in the paper, it sounded interesting. We liked the idea that we could provide the researchers with data they'd be able to work with, data that they didn't need to collect themselves, that they could put together with submissions from all the other volunteers to analyze."

Exactly so.

The Nongame Wildlife Program initiated the calling survey in 1994, spurred by reports of precipitous declines in frog and toad populations around the world—but also in the general interest of good stewardship of the state's biodiversity. From 2003–2015, Minnesota's effort operated as part of the North American Amphibian Monitoring Program (NAAMP), managed by the U.S. Geological Survey.

This federal program was created to address urgent needs identified by the Declining Amphibian Populations Task Force, established in December of 1990 by the International Union for Conservation of Nature and affiliated with the World Congress of Herpetology. An international meeting sponsored by the U.S. National Academy of Sciences earlier that year had affirmed the need for concerted effort to fill gaps in knowledge and produce "scientifically and statistically defensible, long-term distribution and trend data for calling frog and toad populations at both the state and regional level."

This was not only about the well-being of frogs, toads and their kin, since humans also rely on water. It was in our own best interest to know. If amphibians were indeed disappearing, just how great were these declines, where were they occurring and why? Did this portend a biodiversity crisis at a broader scale?

> *"Why did I want to participate? I find contributing to scientific knowledge rewarding."*
>
> **STEVE WESTON,**
> **Survey Volunteer**

"I think the most lasting value is that the NAAMP dataset provides an important historical resource for scientists about frogs and toads. There is no time machine to go collect past information; datasets like NAAMP provide that window into the past."

LINDA WEIR,
Longtime coordinator of the North American Amphibian Monitoring Program (NAAMP) for the U.S. Geological Survey

For the Nongame Wildlife Program and as many as 26 other partner organizations across the central and eastern U.S., NAAMP provided an administrative framework in the form of an interface for uploading and accessing data, managing volunteers, route locations and route assignments, and hosting the online call ID quiz. Data were also made available to the larger scientific community for purposes of research. When NAAMP support ended in 2015, partners retained access to their valuable historical data but were faced with the need to develop their own infrastructure—both a challenge and an opportunity. The Nongame Wildlife Program opted to conduct its survey through the 2017 season, then took a hiatus to retool, with plans to reboot the survey in 2023.

Gray treefrog
Photo by Carol Hall, MN DNR

MN DNR Nongame Wildlife Researcher Krista Larson with a northern leopard frog
Photo by MN DNR

"There's no question that we needed to continue the Frog and Toad Calling Survey in Minnesota. Amphibians are the most imperiled group of animals in the world. If you're going to be monitoring anything, it should be amphibians," says MN DNR's nongame wildlife researcher Krista Larson. Recent research unfortunately reinforces the ongoing urgency. In a 2020 paper published in the journal *Herpetologica*, investigators Evan H. Campbell Grant and co-authors synthesized field data from more than 100 study sites across North America and Europe, reporting steady rates of decline in the number of sites occupied by amphibians. The authors state: "Expressed at the community level, this is consistent with average species richness of amphibians at any location declining at a rate of 50% every two decades." Clearly, we still have work to do.

Many benefits have been derived from the earlier data collected by volunteer community scientists in Minnesota. "First, I think it's so cool that it was a volunteer from the Frog and Toad Calling Survey involved in the rediscovery of cricket frogs in the state, a species that for many years we thought had winked out," says Larson.

"The data also gave us a way to track potential trends like the expansion of bullfrogs beyond their previous range in the state, and declines of spring peepers in urban areas."

Calling Survey data sets have been a key resource for planning. They have been used to determine the list of Species in Greatest Conservation Need that sets priorities for action under Minnesota's Wildlife Action Plan. They have also been used to focus targeted surveys by the MN DNR Minnesota Biological Survey and as a metric (performance measure) for the MN DNR's Conservation Agenda, a 10-year strategic plan that guides the agency as a whole. Species distribution maps (see figures 1 and 2) will continue to inform the state's understanding of population trends.

"There's so much more that can be gained by digging into this data," says Larson. "While NAAMP offered large-scale regional analyses, the state-level species occupancy trend analysis has been our role all along," says Larson.

The most recent analysis of state-wide trends (1998-2015) indicated increases in the number of routes where two species were heard: the green frog and Cope's gray treefrog. Survey results

Figure 1

MINNESOTA ROUTES SURVEYED FOR THE GREAT PLAINS TOAD (ALL YEARS)

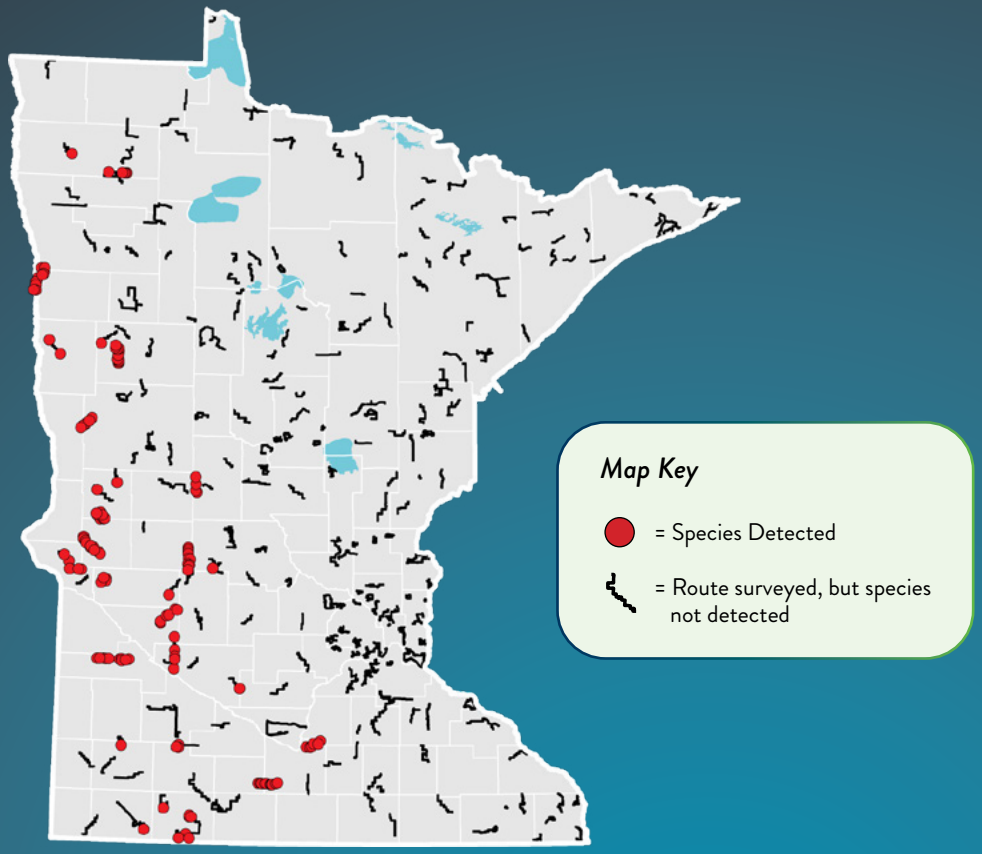
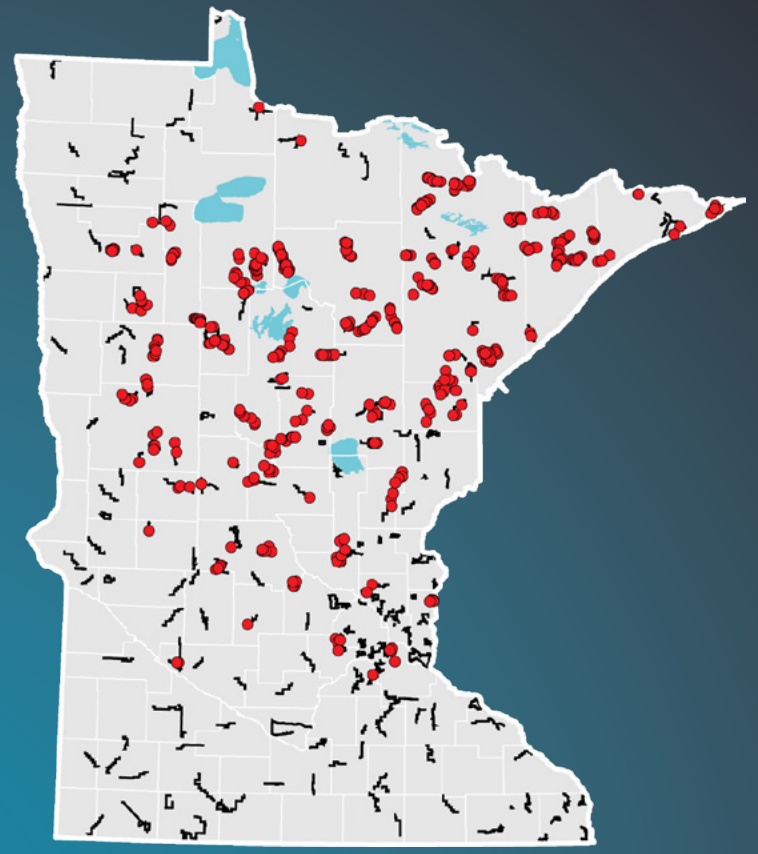


Figure 2

MINNESOTA ROUTES SURVEYED FOR THE MINK FROG (ALL YEARS)



Mink frog
Photo by Kristi Coughlon, MN DNR

did not point to statistically significant changes in abundance of species statewide over this period, which is not to say that there weren't changes in populations in parts of the state.

There are nuances in the interpretation of the data, says Larson. "You can't presume a species to be stable just because statistically significant changes haven't shown up in analyses. Sometimes a trend is evident but just shy of the standard for statistical significance. In other cases, you have to consider the limitations of the survey itself. It's a bit of a leap to say that pickerel frog populations are stable, for example, because they only breed in backwaters of rivers and streams in southeast Minnesota, where we haven't had enough survey routes to show a change one way or the other. Then there's the Great Plains toad, a little more widely distributed, found in the western prairie part of the state. They breed in a super short window, calling explosively after torrential rains, then shut down again, and don't necessarily breed every year, which makes them very hard to detect. So, these are two species that are going to require a different approach, an expansion of routes or a more targeted survey to really understand what's happening. There are also some routes that have historically gone unfilled, that need volunteers to take them on. People tend to gravitate toward routes with the greatest number of species and volume of calls, but negative data is super important for the science. If you're finding a site that used to have species and now it doesn't, that's exactly the kind of thing we need to know."

"I had one site that was really kind of my favorite site because I could hear several different species of frogs throughout the three calling periods each year. And there were a couple types of toads there, American toad and also Great Plains toad. The site had been pasture land for many, many years, probably 30 to 40 years; there was a wetland area and at least one pond out there. Then, the site ended up getting converted to annually cropped lands.

The dugout pond had been filled in and it was cropped from fencerow to fencerow. It had been about an 80-acre pasture. And all I could pick up and hear after that was a wood frog.

And all I could think is, oh my gosh, what a change that is. I'm sure it was related to less water, less habitat, probably fertilizer and chemical application. It was kind of sad, it really bothered me because every year after that it was the same thing; it just didn't have the variety of species and the quantity of species that had been there previous to that. It was really an eye-opener for me and for my kids to hear the difference. You get used to these places, and know what you're going to hear, and all of a sudden it's not there."

KATHY FILLMORE, Survey Volunteer

Nongame Wildlife Program Biometrician Chris Jennelle
Photo by MN DNR

New with Minnesota's reboot of the Frog and Toad Calling Survey is Biometrician Chris Jennelle, who recently joined the Nongame Wildlife Program team. The field of biometry, he explains, applies statistics to biological systems. "You might say I'm a kind of statistical architect," Jennelle says. It's a necessary skill set in researching wildlife populations and their environment, which are complex, dynamic and ever changing. "When we make observations in nature, we can never know the full truth. Biologists spend large parts of their careers counting stuff and then working to make sense of the counts they make in space and time. With surveys like this, we're basically getting snapshots—a sampling—of what populations are doing. To make sense of that, we have to use statistics and theoretically-grounded methodology to build models with variables we think are influencing the patterns we observe in nature, with protocols for how data is collected that are rigorous enough so that these models are defensible. It allows us to have confidence in the inferences we make about the results; in this case, the conclusions we draw about frog and toad populations in Minnesota." Inputs into models include the data provided by survey volunteers but also a host of co-variates: that is, other factors that might influence observations, such as weather conditions, time of year, duration of listening periods and landscape characteristics.

Together, the sampling design, data collection and underlying model structure can provide a useful representation of what is happening to a species across its range. It's not a complete picture, but it can be meaningful. "It serves as a signal detector, a kind of trip wire to detect trends," says Jennelle. "If we analyze the data in the context of the model

and note an apparent drop in a species' relative abundance, especially if it continued over a period of years, we'd know that we have to pay more attention. The wire has been tripped. That's the first pass. The power of the science that we do is that we can follow up on that result with more focused study design that might be at a finer scale, that could help affirm the decline and ideally detect the processes that are driving those declines—whether it's predation, contaminants, disease, habitat degradation, a combination of these or something else. That can guide our recommendations for conservation management.

"If we just surveyed opportunistically, where convenient, or without such a systematic, statistical approach," says Jennelle, "we might never know that a species is getting hammered or might not realize it with enough time to act on the knowledge. We'd be basically blind to the biological loss of the species."

In addition to advising on the study's foundational issues, as a self-described "keyboard jockey," Jennelle will code the statistical models and algorithms, pull in raw survey data from the database, analyze it statistically, and—together with Nongame Wildlife Program biologists—write up the results in the context of the survey's objectives. He doesn't lose sight of the fact that the quality of any inferences to be made is rooted in the quality of the data collected, which is owed to the diligence of people in the field conducting the surveys. "Part of my role is making sure that the efforts they're going through are worth it in the end," Jennelle says.

Transitioning from the earlier calling survey to the new, rebooted survey presents logistical issues for the entire team operating the program. Jennelle likens the process to extending an old railroad track with new track, making sure they align and the train that started rolling back in 1994 will be able to run smoothly the whole length of the track.

American toad
Photo by MN DNR

"I am more than happy to volunteer my time to help the MN DNR discover trends in the state's frog and toad populations, so intervention can be made before an irreversible population decline occurs."

FRAN HOWARD, Survey Volunteer

For Nongame Wildlife Program biologist Mags Edwards, the process has meant taking on the painstaking work of ground-truthing locations of the stops on prior routes to be sure that narrative descriptions of the routes and GPS coordinates are all current, accurate and in agreement. Many routes were originally established from starting and ending locations provided by the USGS, from which volunteers had to figure out a route and 10 stops (listening points). "This was pre-GIS, so people were using the odometers on their cars and their personal wherewithal to describe these things," Edwards says. Descriptions like, "west of road by the little white shed" or "field approach on south side of 45, aspen clump to the east" may have worked fine as reference points for someone already familiar with an area, but not for a person new to the route, especially in the dark. Even features that were once prominent in a landscape may no longer exist. Going forward, many volunteers will be able to use their smart phones for navigation, but not everyone has one, and not every location has cell service. Maps and physical descriptions still have an important place in the calling survey.

Edwards is also heading up the effort to get more people involved as community scientists in the other projects of the Nongame Wildlife Program. "I think that anyone in Minnesota who wants to participate in something like this should be able to, and I'm really committed to its being inclusive in terms of diversity, that everyone feels welcome." Like any aspect of the Nongame Wildlife Program's work, to be successful, it will require adequate staffing and resource levels dedicated to the purpose: a worthwhile investment that can help the program accomplish its aims while also raising public awareness of challenges facing wildlife in our state.

"The original NAAMP survey set the stage and established the baseline long-term monitoring dataset, and we now have an opportunity to build on what we've learned and add nuance to the survey to better suit our frog and toad conservation goals for Minnesota. As a team, we're actively looking at the existing data, reevaluating our research questions, looking into how other states have also moved forward in more focused ways, and making a concerted effort to ensure that the survey design and protocols are giving us the information we need. It's exciting!"

MAGS EDWARDS, Nongame Wildlife Program, Community Science Coordinator

Photo by MN DNR

Where's the frog? Blanchard's cricket frog with its trademark blaze
Photo by Krista Larson, MN DNR

Even when up and running with a full complement of community scientists, Minnesota's Frog and Toad Calling Survey is just part of the Nongame Wildlife Program's vision for conserving healthy populations of the state's fourteen frog and toad species. It is uniquely valuable for its systematic design, with protocols and constraints that generate consistent long-term data for scientific analysis of both species distribution and abundance. But it is one of many initiatives in the hopper, so to speak. Among these, the Nongame Wildlife Program is pleased to have struck a working partnership with HerpMapper, a community science project with a free, publicly accessible mobile app designed and led by a group of midwestern herpetologists. The app allows anyone to upload photos and recordings of reptiles or amphibians from any location. Under the agreement, the MN DNR will be able to download cricket frog data from the site and also offer guidance on where people might consider listening or looking for these rare frogs.

"We really do need a deeper bench on this," says Lisa Gelvin-Innvaer, Nongame Wildlife Program biologist who lives and works in the southwest region of the state. "There's a fleeting sweet spot for doing these seasonal surveys, and it's good to have more eyes and ears out there." She also points to conservation projects that—while not exclusively targeting frogs and toads—serve to benefit their populations and the ecological community as a whole. "For example, stream restoration projects like the one at Lower Mound Creek in Blue Mound State Park," she says, "where they decided to restore the creek after a

dam blew out from extreme flooding. And efforts to provide better technical guidance during environmental reviews of proposed construction or other developments, having early coordination with a project so that we can avoid unintentional negative impacts. We'd like people to know that these are not isolated efforts. It's an overall integrated approach under the Wildlife Action Plan that benefits people too, whether it's reducing erosion and flooding or protecting water supplies. There is the absolutely necessary science that we do, and then there is that connection you get when you work closely with a species in the environment and you see not only what individual animals and populations face but how they fit into the bigger scheme. We also learn a lot from people who are actually embedded in these landscapes. Local landowners are among our best sources of information and make such an important contribution."

There is no denying the gravity of the continuing global declines in amphibian populations. If there is a bright spot—or at least, a takeaway to inspire action—in the synthesis of evidence put forth by Grant and colleagues in the recent *Herpetologica* paper, it is that there is a wide degree of variation in these declines, by species and by region. Further, there is no one-size-fits-all ranking of the threats driving declines, since amphibian species and populations in different places demonstrate differing sensitivity to threats. In other words, Minnesota must define for itself the status of populations here and respond to the unique situations as they are playing out at the local level. The rebooted, redesigned Frog and Toad Calling Survey will put us in a better position to understand what is happening and move the dial in a good direction.

Doing community science in fairly remote places—in this case, listening for frogs and toads after dark—may not be everyone's choice as a volunteer project. But for others, those very qualities have a distinct appeal. "I'll be glad when the calling survey starts up again," says Nick Krueger, a Montevideo physician who, together with his wife, Donna, surveyed a route near Bunde, Minnesota. "It became part of my identity. We're frog spotters, which is to say, *hearers*," he laughs. "The frogs and toads add to the diversity of nature here, but they're also part of the beauty for us, the beauty of the soundscape. It's good to take time to be amazed at the world."

Nick and Donna Krueger, survey volunteers

"They're indicator species for your water quality. They're food for other critters. Everything matters."

DONNA KRUEGER, Survey Volunteer

SELECTED RESOURCES

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Cope's gray treefrog

DID YOU SAY *SIGGEN*?

SPECIES IN GREATEST CONSERVATION NEED, OR SGCN

SGCN designation: A heads-up that a species requires special attention to improve its outlook in Minnesota.

Species in Greatest Conservation Need, or SGCN (the acronym pronounced "*siggen*") is a term used to describe native wildlife species whose populations are in trouble. The term originated in 2000 with a federal program created by Congress to fund wildlife conservation in the states. It is used to describe native wildlife—game and nongame—whose populations are rare, declining or vulnerable to decline and below levels desirable to ensure their long-term health and stability.

Minnesota is currently home to 346 species designated as SGCN, which includes but is not limited to state and federally listed species found within its borders. The state's Wildlife Action Plan outlines strategies designed to benefit these species and is the main mechanism by which the MN DNR's Nongame Wildlife Program receives critical federal funding for its work. When the Plan is approved, it "unlocks" the state's apportioned share of funds from the State and Tribal Wildlife Grant Program as well as its eligibility for additional, competitive grants administered by the U.S. Fish and Wildlife Service.

Canada lynx is one of 346 Minnesota Species in Greatest Conservation Need. Photo by Thomas J. Spence

SGCN designation sparks action. This designation is the impetus to work on everything from landscape-level, multi-partner initiatives on public and private lands (such as creating wildlife corridors linking core habitat areas), to narrowly-targeted projects that seek remedies to threats faced by particular populations (such as flooding of wood turtle nests or dewatering of mussel colonies). It drives research that looks at Minnesota's environment through the lens of these at-risk species, informing strategies that allow people and wildlife to better co-exist.

Alison Cariveau, with the Nongame Wildlife Program, helps to secure funding for research and conservation of rare species.
Photo by MN DNR

"For me, what's fun about this work is, it's focused on a lot of species that are under the radar and under-recognized. They may be hard to find because they occupy a tight habitat niche, or may be present for only two weeks a year as adults, spending the rest of the year as eggs or in larval stages, but they're out there supporting the better known parts of our biota. If we don't pay attention to them, they could be gone. So, we work to reverse negative impacts to the species and their habitats. It's actually a very hopeful program."

ALISON CARIVEAU,
Nongame Wildlife Program Grants Coordinator

Discoveries in the Data: A Selected Sampling

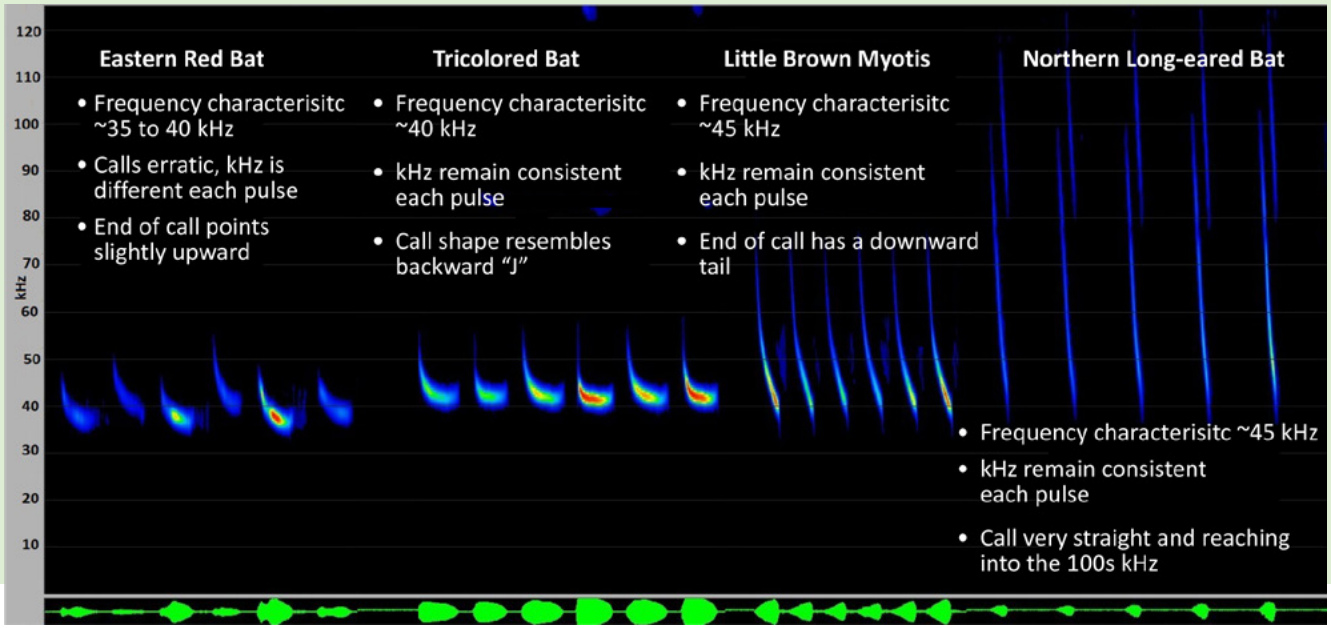

Figure 1. Data from acoustic detectors is generated as an audio file that can be visualized as a sonograph. Bat species recorded on the route are then identified by the characteristic signature of their calls (i.e. shape, frequency minimum/maximum, pulse traits). Calls not identifiable to species can be narrowed to groups.

Bats hold a unique place in these efforts, in that all seven of the state's regularly occurring bat species have SGCN designation. Research is casting new light on these small nocturnal mammals belonging to the order Chiroptera (derived from the Greek, meaning hand-wing).

Since 2009, annual acoustic surveys for bats have been conducted by biologists from the MN DNR's Minnesota Biological Survey and Nongame Wildlife Program, and the U.S. Forest Service. Mobile audio surveys are conducted at night to monitor trends in summer bat activity, with the chief aim of assessing impacts of white-nose syndrome on the state's populations of hibernating bats. Millions of bats in eastern North America have died from white-nose syndrome, a disease linked to the fungus *Pseudogymnoascus*, which can wipe out entire colonies of hibernating bats.

Surveys are undertaken in the period from late May through July. "We start recording along our assigned routes half an hour after sunset and finish by around midnight, each of us driving a 30-mile transect at 20 m.p.h. with a bat acoustic detector mounted on the roof of the vehicle," relates Minnesota Biological Survey zoologist Melissa Boman. Driving slowly along the dirt or gravel county roads, the researchers will often see bats foraging in front of the vehicle. "It's out of our range of hearing, but we know they're emitting the search-phase calls they use when navigating or hunting for insects. These calls are different from the social calls they use while roosting, which are more like a song. It's basically a language from a library we're still building."

Data from acoustic surveys complements data from mist-net surveys, in which captured bats are banded and released. Whereas acoustic surveys can assess call abundance by species to indicate population trends, recaptures from mist-netting can reveal information about individual bats. One little brown myotis bat banded by Minnesota Biological Survey Mammalogist Gerda Nordquist in 1983 was recaptured 32 years later, demonstrating remarkable longevity for a small mammal. Minnesota Biological Survey Zoological Specialist Melissa Boman pictured.

"It's basically a language from a library we're still building."

MELISSA BOMAN, Minnesota Biological Survey Zoological Specialist

Four of Minnesota's bat species (little brown myotis, northern long-eared, tricolored and big brown) are year-round residents that hibernate during winter and three (hoary, eastern red and silver-haired) are present during the growing season but migrate south during the winter. All seven species have been documented through these acoustic surveys.

In more than 10 years of acoustic monitoring, researchers have driven over 10,000 miles along 20 established routes recording the ultrasonic frequencies that bats emit while echolocating. The resulting audio files, visualized in the form of sonographs (see figure on page 23), enable researchers to distinguish between species and compare call abundance from year to year.

As feared, the data confirmed declines in hibernating species. An unexpected result was the decline in call abundance of two migratory bats—hoary and eastern red bats—which are not known to be impacted by white-nose syndrome. The cause of this decline has yet to be determined, but it coincides with increased wind energy production in the Midwest, and similar trends have been observed in other Midwest states. Whether due to wind turbines or other factors, it calls for attention and a timely response to set a better trajectory for these SGCN populations. "With mobile audio monitoring," says Boman, "for the first time we are gaining some hard data on what's happening to the populations of bat species in Minnesota."

Ascertain • Examine • Investigate • Monitor • Survey

When surveys reveal that a SGCN population is present at a given location, the work is only beginning. The operative question is *why*. What conditions are present that allow this species to persist or reproduce here? Management for vulnerable species requires defining and continually refining our understanding of the characteristics of suitable habitat.

Many animals on the SGCN list are highly specialized in their habitat requirements. For example, a manager who aims to "think like a skink" in the Minnesota River Valley where they occur can follow recommendations learned through Nongame Wildlife Program monitoring: control vegetation on bedrock outcrops to maximize areas with more than 25% bare rock and leave downed woody debris (especially oak) greater than six inches in diameter.

Long-term monitoring of migratory species like the common loon calls for work not only in the 600 lakes annually monitored within Minnesota, but also in the places where loons overwinter, such as the Gulf of Mexico. Loons are on the SGCN list primarily due to their vulnerability to contaminants, ranging from lead fishing tackle to oil spills.

Data transmitters implanted in and geolocators attached to loons were key to documenting impacts on Minnesota's loon population from an oil spill in the Gulf. The resulting data gives managers a more complete picture of population vulnerabilities and protection strategies. Today, a special focus on protection of nesting habitat aims to support reproductive success. "While labor-intensive, the ongoing work of population monitoring pays off with interest in the form of insight," says Nongame Wildlife Program Leader Cynthia Osmundson.

"Monitoring projects not only contribute to our understanding of SGCN population status and trends, but also serve as an indicator of the health of the habitats on which they depend."

2015-2025 MINNESOTA WILDLIFE ACTION PLAN

The common five-lined skink, a state listed Special Concern species and SGCN, is associated with granite outcrops in the Minnesota River Valley, and with exposed limestone and sandstone outcrops in the eastern part of the state. Photo by Jeff LeClere, MN DNR

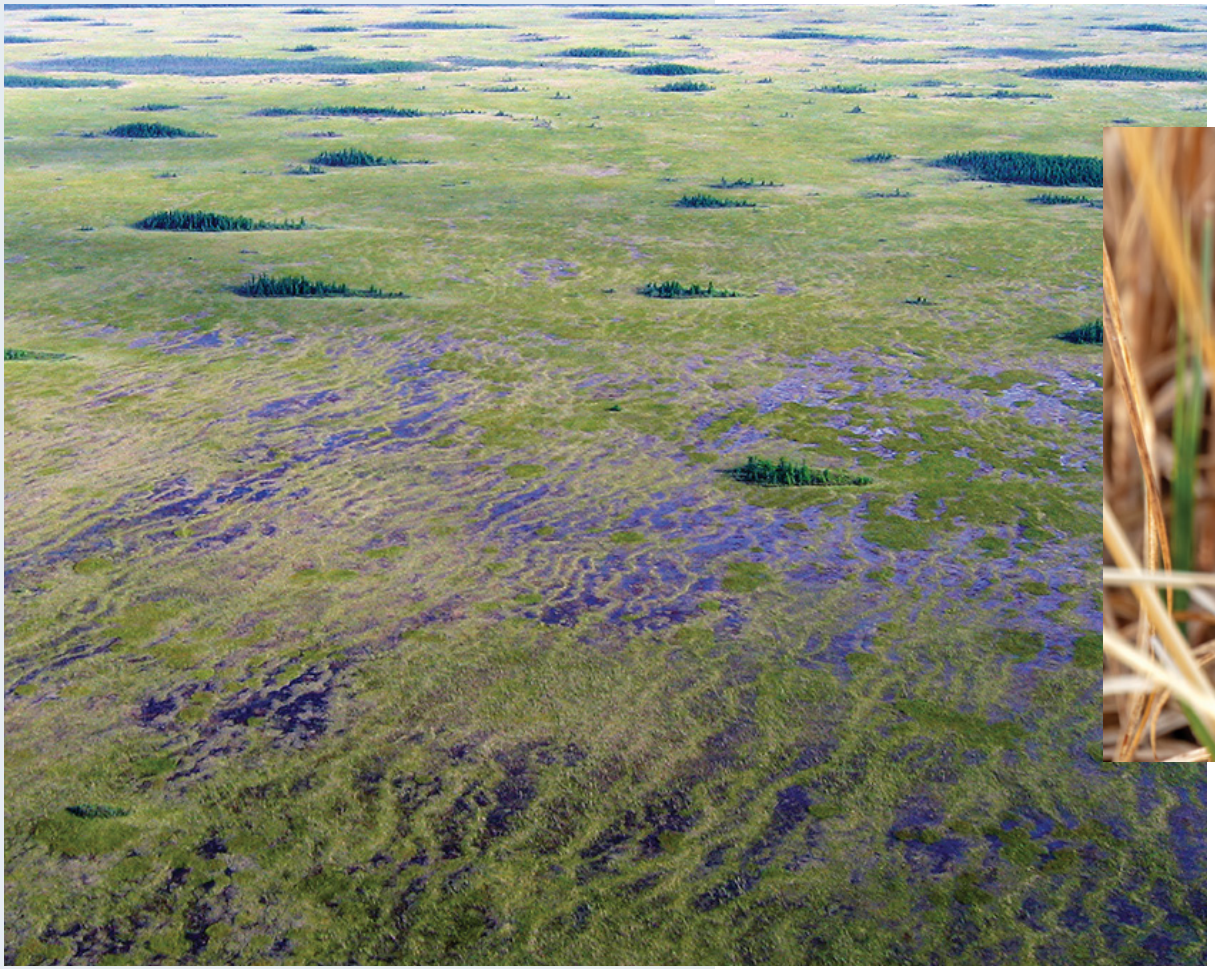

Photo by Erika Rowe, MN DNR

Extensive areas of rich fen in large peatland complexes are recognized as habitat for Nelson's sparrow, a state listed Special Concern species and SGCN. Pictured (at left) is an aerial view of Red Lake Scientific and Natural Area, and a Nelson's sparrow (above).

Piping plover
Photo by Stephen Maxson

Decades of breeding bird surveys inform the protection of critical habitat. Pine & Curry Island Scientific and Natural Area is one of only a few places in the state where the piping plover has nested in recent years. The species is state listed as endangered and is federally listed as threatened. Report of a nesting pair with two chicks offered welcome good news in 2021. Part of the site is designated as a sanctuary, closed to the public April 1–September 1.

Nongame Wildlife Program Biologist Gaea Crozier working with wood turtles in northeast Minnesota
Photo by MN DNR

The Best Use of our Time: Science-based Strategies

Say you have a long-lived species—the wood turtle—that can live 50 years or more but doesn't reach reproductive age until it's about 15 years old. You know that badgers are major nest predators in your area (St. Louis County). A significant number of wood turtles are struck by cars as they cross roads, including gravid (egg bearing) females. Extreme storm/flood events associated with climate change are happening more frequently, jeopardizing nest sites on sandbars and cutbanks along rivers. Adjacent forests where the turtles forage for food have become increasingly fragmented and are now dominated by younger aspen rather than older pine, which new data suggest may impact the quality of foraging habitat.

You hope to stabilize and increase the population of this state listed SGCN. Where do you focus your efforts for the greatest positive impact?

"Population modeling (see figure 2) helped to answer that question," says Nongame Wildlife Program biologist Gaea Crozier. "It showed that increasing survival of eggs/hatchlings had a proportionately higher effect on population size compared to increasing adult survival. We still need to prevent mortality of adults related to cars and other threats, but we're prioritizing efforts on juvenile recruitment."

> *"We still need to prevent mortality of adults related to cars and other threats, but we're prioritizing efforts on juvenile recruitment."*
>
> **GAEA CROZIER, Nongame Wildlife Program Biologist**

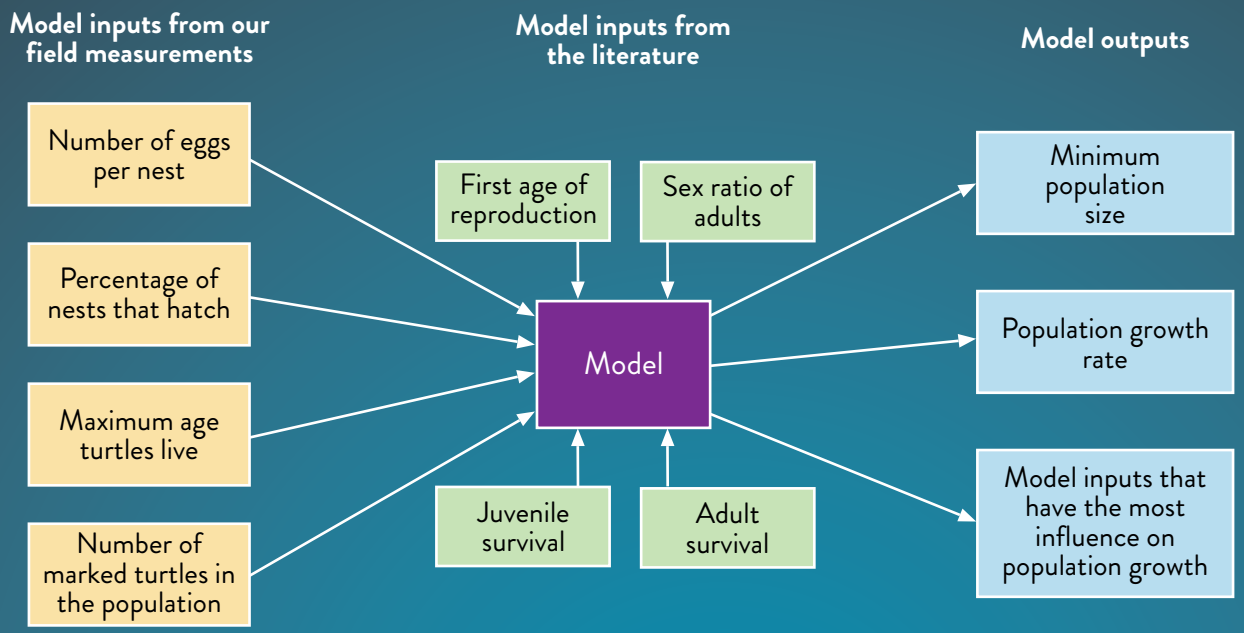

FIGURE 2

Simplified schematic of population model used to determine which management strategies are most likely to benefit the wood turtle population.

Early signs are that it's paying off. Nest cages or electric fencing were installed on six wood turtle nesting sites to protect nests from predators. This resulted in a 50% nesting success rate, as compared to 5% from unprotected nests. These efforts have produced an estimated 174 hatchlings over a four-year period, resulting in a pulse of reproduction into the population.

The work was undertaken as part of the Upper Midwest Turtle Conservation Project, a joint effort involving the states of Minnesota, Wisconsin, Michigan and Iowa funded by a competitive federal grant to state wildlife agencies.

What next? "We're using tiny transmitters to track the hatchlings short-term, with batteries that last just two weeks, to better understand what habitat the hatchlings are using," says Crozier. "But we recognize that represents just a sliver of time. Looking ahead, we really need to better understand what happens in those 15 years before they reach sexual maturity, and help them to get there if we can."

University of Minnesota graduate student Maddy Cochrane collects data on wood turtles in order to inform our understanding of habitat characteristics and survival.
Photo by MN DNR

Baseline monitoring is another important aspect of the state's work on this SGCN. It turns out that field research on wood turtles presents unique challenges requiring refinements in methodology. During the project, turtles moved too slowly to trigger the motion sensor cameras! (Subsequent phases of the project added time-lapse photography).

Graduate student Maddy Cochrane recollects her own experiences following hot on the trail of the state's wood turtles in northeast Minnesota and perspectives gained along the way:

"First, they're very terrestrial. In spring and summer, they might be hidden under brush or grass. Their yellow and black plastron (underside of the shell) is not noticeable from above, so we'd be following a transect crawling on our hands and knees.

"You have to develop an eye for what a turtle butt looks like. Later in the season, we could track individuals we'd affixed with transmitters. Sometimes that meant holding the antennae over our heads as we waded through streams or, in winter, skiing up a frozen river to determine where they were hibernating, getting within five meters or so of their hibernacula in the riverbank or in mud below the ice.

"A lot of the wood turtles we were working with were 30-40 years old, older than we were. They're such beautiful animals with such ancient origins, and they're restricted to these areas where they now face so many obstacles that we've created. It would be great if people became more cognizant of turtles crossing the road and paid them heed. They're just trying to survive and reproduce."

Tiny wood turtle hatchlings need tiny transmitters. The battery life of these small transmitters is really short (the battery only lasts about 14 days). Biologist Gaea Crozier explains, "We need to replace the transmitters about every 12 days before the battery dies to ensure we can continue to track the hatchlings. The transmitter will eventually fall off on its own."

Photo by Gaea Crozier, MN DNR

Sharing the Latest News

A recent five-year report on the state's Wildlife Action Plan offers a closer look into the often solitary work that happens in remote places across the state to support these at-risk species designated as SGCN. There is exciting news, like the long-sought identification of the "host fish" species necessary for reproduction of the federally listed endangered spectacle case mussel, making it possible to rear juveniles in a laboratory setting for reintroduction into selected rivers. Also on the good news front, invertebrate surveys have led to discovery of a moth species in Beltrami County's Red Lake Peatland that is not only new to Minnesota, but new to science.

Sometimes the findings are not what Minnesotans would hope, such as the declines in migratory bat species or the surveys that have not turned up a single crystal darter. But even then, we are further ahead than we were, better prepared for the task of supporting SGCN and a diversity of native wildlife. Unlike the bats, we do better when we're not operating in the dark. And the state's past conservation efforts have taught us that species in decline—from trumpeter swans to peregrine falcons—can sometimes rebound after strategic, concerted efforts.

In the meantime, work continues across the state, much of it focused on research, such as the American kestrel work pictured here, and improving important habitats. There are now channelized streams in southwestern Minnesota that have been re-meandered, their seasonal connections to off-channel habitats re-established. This not only benefits a rare, federally listed endangered minnow called the Topeka shiner, it also benefits people in local communities by slowing down the run-off from extreme storm events and letting it absorb into the soil. Elsewhere, sharp-tailed grouse have rebounded in restored oak savanna/barrens habitat, and "islands" of pollinator-friendly habitat have been created within seas of row-crops for the benefit of regal fritillary butterflies and other prairie species.

This, and so much more. Follow the progress, and find out how you can be part of it at **mndnr.gov/nongame**.

Wildlife Action Plan Coordinator Kristin Hall (right) works with (right to left) Mary Lee (Army National Guard), Mark Martell and Amber Burnette, to study migration of American kestrels, another SGCN. Small transmitters are placed on adult as well as young kestrels just after they fledge from nest boxes. As a result we are able to learn about migration risks and patterns of our smallest falcon. Persistence is a necessary component of conservation.

Photo by Kristin Hall, MN DNR

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Ross Hier

PRAIRIE LIGHTS

KEEPING THE WORLD LIVABLE FOR THE TOPEKA SHINER AND OTHER NATIVE SPECIES THAT RELY ON PRAIRIE STREAMS

"Looking at a little trickle of water or a puddle in a pasture, you might think, 'There's no way there are fish in there.' "

Mags Edwards

"Looking at a little trickle of water or a puddle in a pasture, you might think, *'There's no way there are fish in there.'* Then you'll pull a net through and it will be full of fish," says MN DNR Nongame Wildlife Program biologist Mags Edwards. The fish are gently sorted by hand and identified: orange-spotted sunfish, bullhead, fathead minnow, central stoneroller, sand shiner, southern redbelly dace and—sometimes—the researchers' intended quarry: Topeka shiner.

A type of minnow, this federally listed endangered species averages three inches in length and tips the scale at 0.18 ounces. It is most easily recognized during the breeding season, when the fins, abdomen and cheeks of males turn bright red-orange. "If you get to the right habitat at the right time, when the males are all colored up, they can shine like a spotlight," says Edwards. Positive identification of males outside of the breeding season, females and juveniles requires a practiced eye.

Topeka shiner
Photo by Andrew Herberg, MN DNR

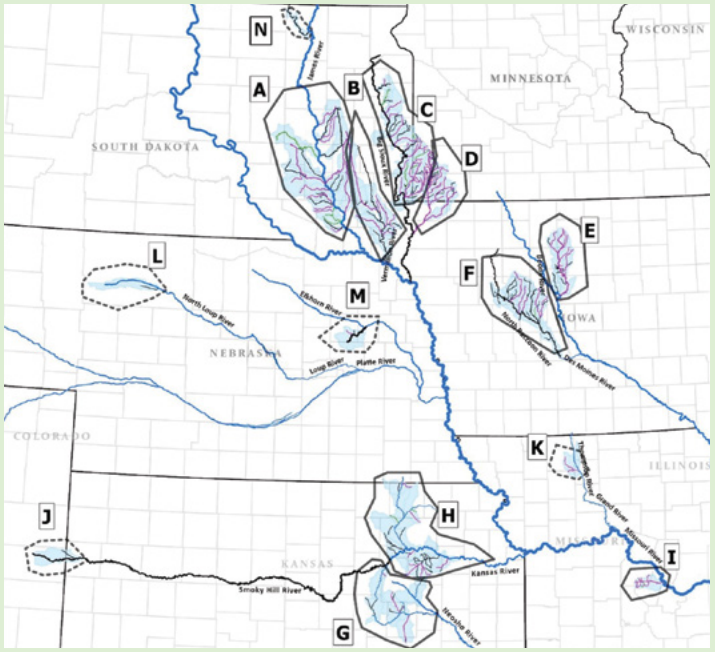
Since 2004, the Nongame Wildlife Program has monitored for the species in the Big Sioux and Rock River drainages, tributaries of the Missouri River in southwestern Minnesota. Field crews sample 20 one-mile stream stretches that are randomly selected each year, within an area designated by the U.S. Fish and Wildlife Service as critical habitat. Other states in the species' historic range (see map) have also monitored for the species.

Sampling work has focused on documenting presence/absence of the species in each assigned stream and assessing watershed values throughout the study area to prioritize sites for restoration.

Crews of two to four go out from late May to early June. Streams are accessed from bridge crossings and, in the case of private lands, with permission of landowners.

Ross Hier

Southwestern Minnesota harbors critical habitat for the Topeka shiner. Historically, this little minnow of prairie streams was widespread and abundant in portions of Iowa, Kansas, Minnesota, Missouri, Nebraska and South Dakota. In 1998, it was federally listed as an endangered species, when its occupied range was thought to have declined by 80%, with most of that loss occurring within the previous 25 years.



Current range of the endangered Topeka shiner. Solid outlined areas (A-I) are the nine population complexes on which the recovery criteria are based. Dotted outlined areas are considered isolated populations and maintain significance for recovery of the species. Map by USFWS (Map from U.S. Fish and Wildlife Service Draft Recovery Plan for Topeka Shiner, *Notropis Topeka*.)

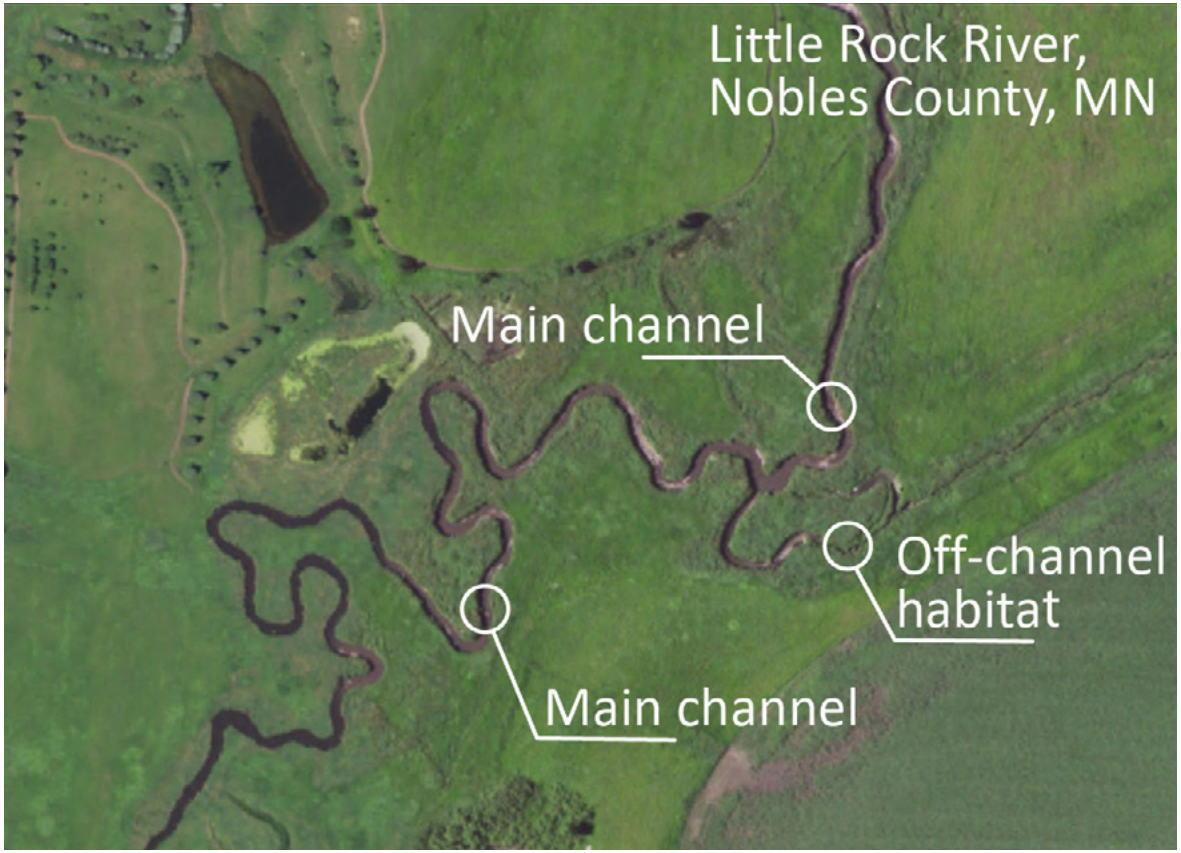
Like Edwards, Nongame Wildlife Program biologist Andrew Herberg has spent many hours in waders drawing hand-held, pole-mounted nets through the water—a method that is only practical for smaller tributaries, the shallower parts of main-stem streams, and pools. Any captured fish are processed and released, then it's on to the next randomly assigned stretch of stream. While the steps are repeated, the work is never routine. Says Herberg, "I wish people recognized the aquatic biodiversity we have in Minnesota—even in these tiny little streams."

One of the truly fascinating things to come out of this work has been the view it offers into the tongue-and-groove relationship between this little fish and its dynamic environment. Topeka shiners have long been known to utilize in-stream pools within the channels of low-velocity, meandering, second-order prairie streams. But in the course of Minnesota's ongoing study, researchers have consistently found the Topeka shiners in seemingly isolated bodies of water as many as 100 meters (greater than 325 feet) inland from streams: in off-channel pools, including oxbow lakes and even murky, waste-laden cattle ponds within the streams' floodplains. "They clearly exist in the streams as well, in order to periodically recolonize these sites," says Edwards, "but we just don't tend to find them there with our current methodology."

A field crew sweeps the sampling net.
Photo by MN DNR

The key is that these off-channel water bodies are not, in fact, isolated. Rather, they are typically fed by groundwater and also replenished by the stream during flood events. These same high-water periods provide opportunity for the Topeka shiners (and other associated species) to disperse between the streams and off-channel pools.

Off-channel aquatic environments are now recognized as important sites for spawning and nursery habitat for this imperiled species in the northern reaches of its range (in particular, Minnesota and Iowa). The fact that the species is still here at all may be due in part to the Topeka shiner's ability to persist—at least for a while—in the high temperature and low dissolved oxygen conditions sometimes associated with these pools.



This Nobles County image of a prairie stream shows Topeka shiner off-channel habitat.

***Oxbows** are the loops in a meandering stream. Crescent-shaped **oxbow-lakes** are created when the stream erodes a shortcut that allows it to bypass and abandon an earlier loop.*

As designed, the monitoring protocols have not generated reliable data on population size. But subjective assessments of the abundance of Topeka shiners relative to other species in those stretches where they've been found have provided opportunity for comparisons between years and an indication of how populations may be trending. An added benefit has been insight into the status of the plains topminnow, a state listed threatened species in Minnesota that utilizes similar habitat.

Minnesota's monitoring work since 2004 has produced interesting—and sometimes startling—findings. For example, observed occupancy in surveyed streams dropped to a low of 30% in 2013 and averaged only 44% in 2010-2014. When averaged over the first 14 years of monitoring (2004-2018), Topeka shiners were present at 66% of surveyed stream stretches in the state. The report, *Topeka Shiner Monitoring in Minnesota: 2019*, prepared by MN DNR biologists Andrew Herberg, Mags Edwards and Melissa Boman concludes, "Overall, our monitoring results indicate that Topeka shiner populations in Minnesota may be relatively stable despite short-term fluctuations in observed occupancy and relative abundance."

While Minnesota and South Dakota are considered to harbor only 20%, in area, of the estimated former range of the species, they stand to play a key role in the fate of the Topeka shiner. A 2018 U.S. Fish and Wildlife Service Status Assessment noted that, "Post-listing, increased survey efforts revealed additional extant populations, particularly in South Dakota and Minnesota, while population losses and/or reductions appear to continue in other states despite listing protections afforded by the Endangered Species Act."

"I wish people recognized the aquatic biodiversity we have in Minnesota—even in these tiny little streams."

ANDREW HERBERG,
Nongame Wildlife Program Biologist

Topeka shiner
Photo by Mags Edwards, MN DNR

Applying What We Know Now

Call in the heavy equipment! It's not the usual rallying cry for restoration. But bulldozers, wrecking balls and front-end loaders are playing a key role in restoring habitat for the Topeka shiner. In an array of projects, channelized and ditched streams have been re-meandered, seasonal connectivity has been re-established between streams and off-channel habitats, and sediment has been excavated from dozens of relic oxbow pools, restoring contact with groundwater. Work has also focused on removal of barriers to fish in streams: stair-steps of "rock riffles" have been built to allow passage over low dams, while other dams have been removed entirely. A wonderful presentation by Windom, Minnesota-based U.S. Fish and Wildlife Service biologist Scott Ralston includes before, during and after images of many restorations (See link, Selected Resources). Among them are a channel shift in Pipestone County's Flandreau Creek that transformed a straight, channelized stream section into a lacework of meanders (see before and after images on page 40), and restoration of a system of oxbow pools associated with Mound Creek in Rock County's Blue Mounds State Park.

Scott Ralston, Fish and Wildlife Biologist
Photo by U.S. Fish and Wildlife Service

Restored oxbows provide habitat for Topeka shiner and associated species.
Photo by Scott Ralston, U.S. Fish and Wildlife Service

Federal funding for the Topeka Shiner Cooperative Recovery Initiative has enabled a host of projects coordinated by the U.S. Fish and Wildlife Service Midwest Region. These cooperative efforts bring together partners at state and county levels, along with landowners. Habitat information gleaned from 14 years of Nongame Wildlife Program surveys has informed the design of these restorations and prioritization of projects. MN DNR contributions have included mapping of stream/floodplain geo-morphology, and LiDAR (Light Detection and Ranging), instrumental in identifying potential project locations. LiDAR reveals relic meanders and oxbows by detecting depressions in the landscape to a degree not possible through interpretation of aerial photography. The good news is that sampling indicates that Topeka shiners are using these restored environments. Ralston cites sampling results from the 2014-2022 period showing roughly 90% of restored oxbows occupied by Topeka shiner, along with 28 other fish species.

Restoration of Flandreau Creek, Rock County, MN. Before (left) and after (right)
Photos by Scott Ralston, U.S. Fish and Wildlife Service

It's the kind of relationship that makes one marvel: a small fish persisting in pools of water in a landscape that is now largely used for cultivation and pasture, whose reproductive success and very existence on the planet are to some extent reliant on seasonal floodwaters that may or may not arrive. The life strategy of utilizing off-channel pools in such a naturally dynamic environment has likely always made Topeka shiner populations vulnerable to variables such as prolonged drought. But climate change, groundwater withdrawals for other uses, chemical run-off, siltation, dams and other widespread alterations to hydrology have further upped the ante for the species.

Nongame Wildlife Program biologist Mags Edwards hopes that, in the future, funding will allow for methodology to better measure abundance. Increased use of eDNA technology—in which a mere sample of water reveals whether the species is present or absent—could make stream surveys more efficient, allowing monitoring work and restorations to extend to likely habitat.

"It's great that our work is contributing to the conservation and recovery of this iconic prairie species," says Edwards. "We recognize that the Topeka shiner's success or failure in Minnesota does not exist in a vacuum. Although it's just one little fish, its struggles to persist represent a common thread for native flora and fauna throughout a changing landscape. The conversion of prairie to cropland and pasture has had profound impacts on our ecosystems as a whole, and the wee Topeka provides us with a lens through which we can interpret and appreciate this change.

"Our efforts to conserve this species will benefit a host of other species that might not be receiving as much attention, such as the plains topminnow and Blanchard's cricket frog, as well as shorebirds and waterfowl, and all the species that evolved as part of the complex, interrelated tableau of the prairie."

"Ideally, a restoration should look like an unaltered stream...like we were never there."

LUTHER AADLAND
(in) *Reconnecting Rivers: Natural Channel design in Dam Removal and Fish Passage*, Minnesota DNR

MN DNR River Ecologist Luther Aadland
Photo by MN DNR

It pays to recall that many of the streams of Minnesota's prairies were initially altered in the interest of improvement. Their flow was regulated, channeled and dammed to serve various purposes, including flood control. As retired MN DNR River Ecologist Luther Aadland relates in the book, *Reconnecting Rivers*, over time, recognition of the impacts of these "improvements" has grown, ranging from channel instability, loss of habitat, impairment of water quality and increases in peak flow. The kinds of restorations undertaken for the Topeka shiner address many of these issues to the benefit of local human communities as well. The re-meandering of streams, for example, has been linked to improved water quality, erosion control and floodwater storage. Topeka shiners and plains topminnows often disappear from streams like Mound Creek upstream of barrier dams. But after the South Dam failed and was later removed and the stream restored, Topeka shiners, plains topminnow and a number of other species returned. It's not so much about turning back the clock as setting the stage for what happens next and thinking carefully about what constitutes an improvement over the long term. Aadland draws from the writings of Ebersole, Frissell and Ralph (see Resources) in defining restoration as "the act of relaxing human constraints on the development of natural patterns of diversity,... identifying and reestablishing the conditions under which natural states create themselves."

Thanks to willing landowners, more oxbow pools now reflect the sky in the southwest corner of Minnesota. In flood seasons, fish will be able to move freely between these pools and nearby prairie streams as they have in years past. There is much that remains to be done. But for now, there are still Topeka shiners growing brighter every spring. And that's no small thing.

"People say, 'Why should I care about Topeka shiners, this little fish that looks like bait?' There's a whole interconnected community of life here in the Prairie Coteau conservation focus area; a community that humans are part of, too. So, if Topeka shiners aren't doing well, that might mean that the rivers and streams or our own water supplies aren't doing well. That's true, but it goes deeper than that. When I was a kid, my parents taught me to be respectful of wildlife: to look at them, love them, learn from them. Statistics have their place, but it's not what makes people care. For that, you can start with wonder."

Nongame Wildlife Program Biologist Lisa Gelvin-Innvaer
Photo by MN DNR

SELECTED RESOURCES

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FOREST DWELLERS

CONSERVING THE NORTHERN GOSHAWK AND OTHER AREA-SENSITIVE SPECIES OF MINNESOTA'S MATURE NORTHERN FORESTS

It begins in March, typically in the tallest and largest trees of densely forested stands. The mated pair work through the lengthening days, building a new nest or refurbishing an old one with new sticks. Each nest is serious real-estate—2½ to 3 feet across—requiring a solid foundation. Some are snugged against the tree's trunk on sturdy horizontal branches. Others are built in a primary crotch at the base of the canopy. Here in Minnesota's northern forests, mature aspens are favored above all as nesting trees, but a breeding pair may also choose a paper birch, red pine, sugar maple, white pine or jack pine in their territory that is large enough to serve the purpose.

Sprigs of fresh greenery—often pine needles or white cedar—line the nest, a final touch. It will be early April when the female lays first one egg, then two, sometimes a third and fourth, over a period of days. When the last egg has been laid, she hunkers down, taking on the greater share of incubation while the male takes on the greater share of hunting for food. Weeks pass as she periodically turns the eggs and works to keep them warm through the still-cold days and nights, holding them against the bare skin of her brood patch. Now and then, a molted flight feather floats down

Northern goshawk
Photo by Michael Furtman

to land on the ground below the nest, where snow commonly still lingers. There are long spells of quiet, punctuated by the occasional howls of wolves, the tapping of woodpeckers, the *chirr* of a red squirrel or throaty croak of a raven. This is a vulnerable time. Many eggs do not make it through to hatching. But one day, nearly a month after they were laid, there can be a new sound in the forest: the sound of goshawk chicks vocalizing from within their eggs. Near the time of their hatching, new leaves unfurl overhead to screen the nest from above, forming a near-continuous canopy across much of this breeding pair's long-established territory. High in their nest, the young goshawks view this world of shadow and dappled light through bright yellow eyes.

The body of knowledge related to Minnesota's northern goshawks has expanded dramatically in the past twenty-odd years, as state and regional scientific studies have uncovered many secrets of this notoriously secretive accipiter. We had a lot to learn. Studies done elsewhere on the species—in particular, in the mountainous western U.S. and Canada—could not be taken as relevant here, where everything from elevation to vegetative cover to prey species was different. Each question had to be addressed anew, in this landscape setting.

What was the species' range in Minnesota? What was the size of its resident breeding population? How large a territory was needed to sustain a breeding pair and its young? What characteristics defined suitable habitat for nesting and foraging? How did productivity here compare to elsewhere? Above all, how were Minnesota's northern goshawks faring? Were their numbers declining, stable or increasing?

A watchful northern goshawk chick at a nest
Photo by Amber Burnette

The northern goshawk nests in mature and old upland forest, favoring aspens as nesting trees in stands 60 or more years old. In Minnesota, productive breeding territories are associated with large, contiguous forests with greater than 60-70% canopy cover.

In 2013, the goshawk was designated as a state species of Special Concern on the basis of past and projected declines in availability of this type of habitat, together with the species' relatively low abundance and reproductive rate in the state. It is considered a Sensitive Species on the Superior and Chippewa National Forests in Minnesota and is a U.S. Fish and Wildlife Service bird species of management concern.

"The better we understand the species' minimum requirements for nesting and foraging, the better chance we have to sustain the existing breeding population distributed across the species' range."

GAEA CROZIER,
Nongame Wildlife Program Biologist

Photo by MN DNR

The answers mattered, if the goal was to sustain the northern goshawk as a facet of Minnesota's natural heritage. And that was the goal.

The MN DNR Nongame Wildlife Program's work on the species picked up steam in the 1990s, with the impetus provided by the northern goshawk's candidacy for federal listing under the Endangered Species Act. Nongame Wildlife Program funding was provided to the University of Minnesota in support of their research on habitat use, diet, and methodology for monitoring goshawk territories. "But systematic, annual monitoring of nest sites and breeding territories really began in earnest with federal grant funding to the state starting in 2003," says Nongame Wildlife Program biologist Gaea Crozier. "In the years since then, an interagency team of collaborators has continued the effort, with partners monitoring lands they manage across the goshawk's range in north-central and northeastern Minnesota."

Monitoring begins in mid-March each year. Surveyors typically go out solo, checking known nest locations and documenting any new nests observed in previously occupied territories. Northern goshawks are elusive, both rarely and barely seen as they dart through their densely forested habitat. (It is telling that the popular birding website eBird describes adult goshawks as "distinctive if seen well.") Accordingly, surveyors employ a variety of techniques. The protocol includes broadcast of recorded calls from locations at set distances from the last used nest in each territory. A goshawk in the vicinity during the breeding season may give a vocal response to these recordings and/or fly in close enough to be seen, providing a way to determine whether a given territory is still active. It's not failsafe, since the hawks may not always respond or may be too far away during the brief period when the recording is broadcast. But it's a useful strategy to assess the presence or absence of a breeding pair in a remote landscape where single territories can occupy as many as 25 square miles.

The fiercely protective nature of northern goshawks can make monitoring an adventure. "You'll hear this loud *Ke-Ke-Ke-KEH* coming from right behind you, and you feel the wind as they pass over you, inches from your head," laughs Crozier. Rarely, when an adult goshawk dive-bombs an intruder in its territory to defend a nest, they'll

manage to connect. Field researchers have been known to wear hard hats, dodge behind trees, even roll on the ground. "Let's just say they can get your heart racing," she says.

The species' preferred habitat also creates obstacles to monitoring, commonly in remote settings in the interior of large blocks of forest, sometimes far from the nearest road. There can be deep snow even in late spring in Minnesota's north country. The forest floor in the mature northern forests where the goshawk nests is characteristically rich in woody debris, with tangles of fallen branches and downed logs in varying stages of decay. In combination, these qualities make for difficult and slow going for those who are out there trying to better understand the goshawks' status and habitat needs. Modeling of habitat availability has been important in guiding efforts to identify new territories, but the backbone of the work through the years has been the commitment of people in the field.

"It's been a big investment in time from a lot of people, and well worth it," says Crozier. "Monitoring has provided us with a wealth of information on the breeding status, nest location, and nest fate of mated pairs across the goshawks' range in the state." Data collected each year on the more than 70 cooperatively-monitored territories is stored in Minnesota's Natural Heritage Database, providing opportunity to integrate the habitat needs of northern goshawks into forest planning and management. "The better we understand the species' minimum requirements for nesting and foraging, the better chance we have to sustain the existing breeding population distributed across the species' range," she notes. Habitat assessments done as part of monitoring provide managers with insight on vegetation type, structure and scale associated with successful nesting and, conversely, conditions associated with abandonment of territories. This information has been incorporated into management considerations put to use in many goshawk territories on public lands.

Decisions on how best to utilize the information rest with those who own and/or manage the land. Much of the area ranked as priority habitat in Minnesota is located on land administered by the MN DNR and the State of Minnesota. Most of the remaining priority habitat is within the proclamation boundaries of the Superior and Chippewa National Forests, a checkerboard of federal, state and private lands with a significant tribal component.

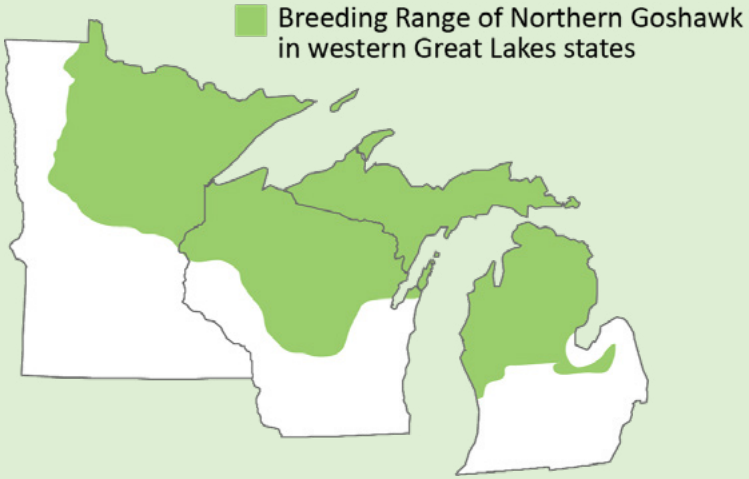
Nongame Wildlife Technician Bruce Lenning broadcasts recordings of goshawk alarm calls and juvenile begging calls, hoping to elicit a response.
Photo by Kristi Coughlon, MN DNR

Dr. David Andersen heads the Minnesota Cooperative Fish and Wildlife Unit at the University of Minnesota and has been investigating northern goshawks since the mid-90s. He has been lead author and co-author on over a dozen scientific studies of the species in the western U.S. and the Midwest, and was among the authors of the foundational 2011 study, *Northern Goshawk Monitoring in the Western Great Lakes Bioregion*. It was the first large-scale effort in Minnesota, Wisconsin and Michigan to assess goshawk populations and habitat relations from this regional perspective, providing context and methodology useful in later studies with different but complementary objectives.

University of Minnesota Cooperative Fish and Wildlife Unit leader, Dr. David Andersen

Andersen's work in other regions has given him a unique perspective on the species here in Minnesota. "We've learned that the northern goshawk is fairly widespread in the U.S., but at low densities in many places. They tend to use older patches of forest in the landscapes where they occur, but the structure of those patches is different in different regions. So, a place where a goshawk chooses to nest in northern Minnesota forests doesn't necessarily look a lot like where they nest in Pacific Northwest forests. Something that's old here might be 60 years old, while something that's old there might be 120-150 years old. They're considered generalists when it comes to diet if you look at the big picture, but within specific regions relatively few things make up the bulk of what they eat. In the far north, they're eating snowshoe and arctic hares, whereas here in Minnesota—at least during the breeding season—they're eating smaller prey, such as

The northern goshawk is sparsely distributed across its breeding range in the Western Great Lakes states of Minnesota, Wisconsin and Michigan.



Map source: Conservation Assessment for Northern Goshawk (Accipiter gentilis) in the Western Great Lakes Region, Dr. John Curnutt, USDA Forest Service, Eastern Region. 2009.

red squirrels, chipmunks, woodpeckers or crows."

The relatively large territories they require in Minnesota suggests that prey availability is comparatively lower here than in some areas of the species' range, Andersen says. "Our studies have taught us a fair bit about the characteristics of the forests they're using in this bioregion. They tend to nest in areas of tall trees where not a lot of light gets to the forest floor and where canopy closure is high. The structure beneath the canopy is also an important feature, generally having some open, unobstructed space where they can maneuver." Telemetry studies indicate that younger forest is not a preferred habitat for goshawks, based on the amount of use compared to its availability. "But, based on what they're eating, some of their foraging may occur at the interface between older and younger forest."

For all that has been learned, we still lack reliable estimates on the size of the breeding population in the state, largely due to the cost of mounting the necessary research. Counts during fall migrations at Duluth's Hawk Ridge—considered one of the top places in the country for goshawk viewing—are understood to be predominantly birds moving into Minnesota from territories to the north. Data from monitoring of nests and active territories provides information on breeding rates in Minnesota and offers timely feedback as to whether goshawks are finding conditions sufficient to keep them there. Fresh insights are expected from a cumulative analysis of monitoring data to date, which is underway by members of Andersen's team in collaboration with

Northern goshawk
Photo by Michael Furtman

A northern goshawk nest in a mature conifer forest
Photo by Michael Furtman

Northern goshawks serve as a bellwether for a whole suite of species that rely on large, contiguous areas of older forest.

the Nongame Wildlife Program. An additional strategy of the Nongame Wildlife Program and the U.S. Forest Service to identify individual goshawks by DNA analysis of molted feathers will further inform studies of the goshawks' movements in the context of habitat change from timber harvest, natural disturbances or other factors.

"Northern Minnesota and the western Great Lakes region is a dynamic landscape for a variety of reasons," says Andersen. "The big question is, what is the landscape going to look like in the future, and will that continue to support goshawks? Will there be a state of flux similar to the last 75 years or will there be a broader change?" He cites a recent assessment of forest conditions in the Black Hills of South Dakota and Wyoming, where he provided technical assistance in a study completed for South Dakota Game, Fish and Parks. "We concluded that changes had occurred there at a scale where the structure of the forest is no longer as conducive to supporting goshawks," says Andersen. Lead investigators Jason Bruggeman and Pat Kennedy summarized the findings: *Goshawk nest-site habitat suitability decreased across the Black Hills National Forest over the past three decades. The results suggest much of its high-quality nesting habitat was lost during this period due to a combination of timber harvest and natural disturbances.*

There are challenges, no doubt, in trying to sustain a species with the habitat requirements of the northern goshawk. Not all variables are in our control and for those that are, it is the classic balancing act of natural resource management—the give and take that allows society to glean one set of high value, desired resources at a scale and in a manner that allows other high value, desired resources to endure. The beauty of this particular equation is that, over the long term, the same conditions that sustain goshawks are important to the health of the forest ecosystem as a whole.

"There are benefits to having large contiguous areas of old forest, beyond habitat for certain charismatic wildlife species," says Dr. Lee Frelich, Director of the University of Minnesota Center for Forest Ecology. "These include carbon storage, soil health, water quality, maintenance of plant diversity (and therefore maintenance of the plant-pollinator network), and an entire food web based on large coarse woody debris, with many species of insects, fungi and mosses, along with seed beds for trees and plants. These old forests also show us how the landscape functions—the patch dynamics, variation in disturbance effects, frequency of microhabitats across the landscape, and the role of very large trees."

Taking goshawks into account is nothing new for many public land managers across the goshawks' range in northern Minnesota. "I've been on the forest for 32 years, and we've been tracking goshawks most of that time," says Jeremy Cable, who leads the Monitoring, Inventory and Survey Team (known as MIST) for the Chippewa National Forest. "We've worked with the Nongame Wildlife Program on goshawk monitoring for many years, and it's been a very successful partnership for us. We've relied on Gaea and the Nongame Wildlife offices in Grand Rapids and Bemidji to provide a lot of the leadership with the timing and phenology of what the goshawks are doing. Gaea is usually out checking a little bit ahead of us

MN DNR Interns Emma Vanhdy (left) and Cheyanne Rose (right) observe a fledged chick near a nest with biologist Gaea Crozier (center). Photo by Cynthia Osmundson, MN DNR

Juvenile northern goshawk
Photo by Michael Furtman

on the territories, to see whether the birds are active yet, and she's helped train new, inexperienced crews in the techniques that are followed, so we use the same methodologies. Among the MN DNR, the Chippewa National Forest and the Leech Lake Band of Ojibwe, we're typically able to cover all the active territories on the forest annually, sharing our data at the end of each season."

The northern goshawk is designated as a Sensitive Species in the Chippewa and Superior National Forests: a designation that brings with it a special management emphasis to ensure their continued viability. No proposed actions potentially impacting goshawks are to occur in the forests without analysis of the significance of adverse impacts on the populations, habitat and viability of the species. "I don't think there's any debate that goshawks need an element of mature forest, and they also need continuous forest," says Cable. "So, it's important to make sure that there are adequate tracts of that. And they benefit from being away from edges where other species, like great horned owls and raccoons, may present predation risks. They're also sensitive to disturbance, especially at certain points in the breeding cycle when they're more likely to abandon a nest. The Chippewa is a working forest, with managed vegetation and an active timber harvest program. We have both older and younger forest stands. The monitoring effort enables us to track the known goshawk territories, and before we do new management, we survey to detect whether there's anything we've missed, so we can see how populations are doing."

"The monitoring effort enables us to track the known goshawk territories, and before we do new management, we survey to detect whether there's anything we've missed, so we can see how populations are doing."

JEREMY CABLE, Monitoring and Survey Team Leader, Chippewa National Forest

It's the role of U.S. Forest Service wildlife biologist Melissa Gabrielson to bring the MIST goshawk data to bear on decisions regarding proposed projects in the Chippewa National Forest. "The goshawk actually falls under two categories in our forest plan—a Sensitive Species and a management indicator—with extensive standards defined to maintain their viability," says Gabrielson. "This includes a nest buffer zone for both active and inactive nests, and a surrounding post-fledging area buffer zone."

In particular, guidelines call for prohibiting or minimizing activities that could disturb nesting pairs during the critical nesting season of March 1–August 30. Nest buffer zones apply to a 50-acre minimum (860-foot radius) of nests where high-quality habitat conditions are to be maintained, protected or enhanced. These conditions are defined as 100% mature forest (more than 50 years old) with greater than 90% canopy closure and large trees capable of supporting nests. Slightly different standards apply to the larger, 500-acre post-fledging zone, calling for greater than 60% of upland to be forested and greater than 70% closed canopy. "Within that nest buffer zone, typically whatever the proposed activity is, you're not doing it," says Gabrielson. "If there is an activity proposed in the post-fledging zone—selective thinning, for example—it would have to take place outside of the goshawks' breeding season and serve to benefit the species by preserving high-quality habitat."

Gabrielson considers, "You could ask, is this too conservative? Are we playing it safe by giving them these large buffers? Extensive analysis went into the forest plan, and it's based on science and research showing that this is what the birds need. And we can see from the data that Jeremy and the monitoring team have diligently collected over the years that we still have those goshawk nests and those territories still exist. These spectacular birds are still on the landscape. We can't necessarily credit our actions as the reason, but that's what you want to see: we're maintaining the viability of a Sensitive Species in the context of a working forest."

Jeremy Cable now spends more time in the office coordinating monitoring than out in the field. But his hopes for

"The goshawk actually falls under two categories in our forest plan—a Sensitive Species and a management indicator—with extensive standards defined to maintain their viability."

MELISSA GABRIELSON,
U.S. Forest Service Biologist

U.S. Forest Service Biologist Melissa Gabrielson

Black-throated blue warblers share the forested landscape. Photo by Sparky Stensaas

the goshawk have not changed. "I think it's what we all hope for, which is stable, sustainable populations that don't blink out and that continue into the future. The more that the different ownerships collaborate—the Forest Service, the MN DNR, the counties, the tribes—the more we work together, the more likely we are to create a landscape that produces what the country needs but at the same time ensures that the conditions are still there for these species."

Nongame Wildlife Program biologist Gaea Crozier agrees. As a state species of Special Concern and Species in Greatest Conservation Need, the northern goshawk warrants thoughtful consideration in the MN DNR's management of state-owned and managed lands.

"Fortunately, we've gained a better understanding of the species' limiting factors in this region, including the conditions they require for successful nesting and during the 6-8 week period when fledglings are still dependent on the adults and learning to hunt." MN DNR's management guidelines for goshawks are linked to the Rare Species Guide (see the Selected Resources at the end of this story).

For now, in Minnesota, there are pairs of northern goshawks fiercely defending their vast territories in the state's northern forests. By all accounts, they are good at it. But there's only so much they can do on their own.

Conserving northern goshawk habitat benefits many Minnesota species, including these Species in Greatest Conservation need:

- Boreal owl (species of Special Concern)
- Wood thrush
- Black-throated blue warbler
- Winter wren
- Philadelphia vireo
- Northern long-eared bat (federally Endangered)
- Big brown bat (species of Special Concern)
- Little brown bat (species of Special Concern)
- Tricolored bat (species of Special Concern)
- Silver-haired bat
- Four-toed salamander (species of Special Concern)
- Eastern red-backed salamander

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Northern goshawk
Photo by Liz Harper

DRIFTLESS ODYSSEY

SUSTAINING A DIVERSITY OF WILDLIFE IN A SPECIAL PLACE

As Yogi Berra said, "You can observe a lot by watching." A timber rattlesnake sunning on a rock ledge outside its bluff-top den; the caterpillar of a regal fritillary butterfly feeding on a prairie birds-foot violet; a peregrine falcon dropping from a cliff face to snag a songbird mid-air; a Blanding's turtle making its June cross-country trek from a wetland to upland dunes to lay her eggs—in each of these, we see the culmination of a kaleidoscope of past events. Even species co-existing in the same landscape, in some respects having a shared history, arrive at the present moment via distinctly different routes.

Accordingly, wildlife ecologists study landscapes as much as they do wildlife, seeking to understand the conditions, processes and relationships that allow a given species to persist in its historic range. The aim is to preserve these essential elements where possible and to restore them where they are marginal or lacking. The MN DNR Nongame Wildlife Program has a special focus on species that are rare, declining or vulnerable to decline, as

Queen's Bluff along the Mississippi River in King's and Queen's Bluffs Scientific and Natural Area, Winona County
Photo by Jay Rendall, MN DNR

prioritized under the state's Wildlife Action Plan. But the eye is always on the prize: healthy, functioning natural systems that support the state's diversity of wildlife as a whole.

The stakes are especially high in the southeastern corner of Minnesota. Described in the state's ecological classification system as the Blufflands Subsection, this string of counties along the Mississippi River (Goodhue, Wabasha, Winona, Houston), along with much of adjacent Filmore County, is home to 151 Species in Greatest Conservation Need. These include 103 species that are federal or state listed as endangered, threatened or of Special Concern. They represent the highest totals for any of the state's 28 Ecological Subsections. Put another way, nearly half of all state listed rare animal species are found in the Blufflands: a truly remarkable concentration.

Why such species richness?

Depending on your perspective, you could say it has to do with how history unfolded here. Or, rather, how it didn't.

From roughly 23,000 years ago until 12,500 years ago, when glacial ice last worked its way across the land that would later become Minnesota, it missed this region. It is widely known as the Driftless Area—a name suggesting that it lacks sediment deposited directly by glaciers.

"But, the short story is that Minnesota's Driftless Area is not truly driftless," says Tony Runkel, lead geologist with the Minnesota Geological Survey. "It did escape the most recent glaciations that muted the landscape in much of the rest of the state, but one or more much older glaciations (somewhere between 500,000 and 2.6 million years ago) did cross southeastern Minnesota and leave behind thin and patchy sediments." See figure 1, which depicts the area in southwestern Wisconsin and northwestern Illinois that is more accurately described as the "true" Driftless Area: that is, never glaciated.

Figure 1. Age and distribution of glacial deposits surrounding the Driftless Area, showing general direction of ice flow for glaciers that bounded the Driftless Area

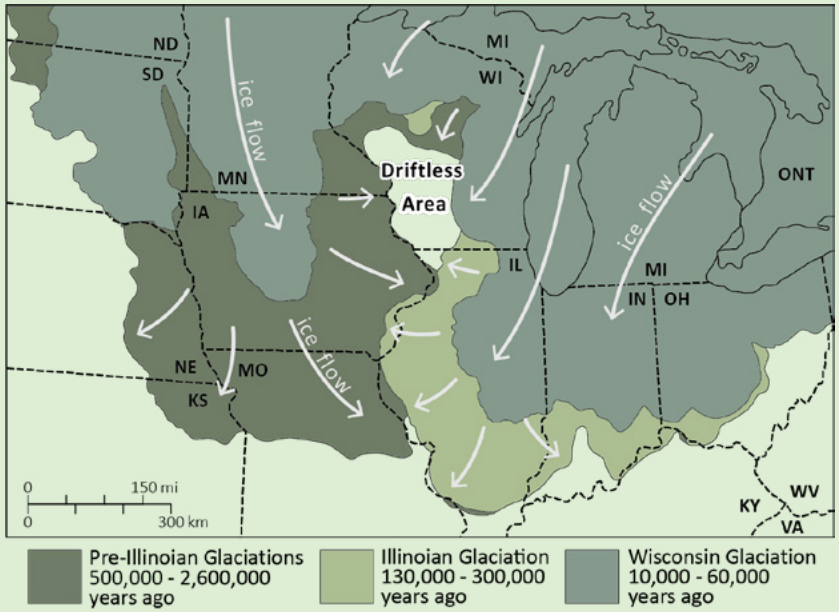

Image courtesy Wisconsin Geological and Natural History Survey (University of Wisconsin, Madison).

Small waterfall in Minnesota's Driftless Area
Photo by ColdSnap

Still, for Minnesotans, "The Driftless Area" is likely to stick. It evokes a distinct landscape with its own cultural identity and associations, and has taken on new meanings over time. Says Runkel, "More and more, it's become associated with the recognition that the area is relatively fragile environmentally."

There is no question that missing out on that last steamrollering by glaciers (and the associated burial in sediment) has had profound implications for life in this region. Since the earlier glaciations were so long ago, there has been abundant time for other natural forces to sculpt the land. The result has been a place of great contrasts. The classic topography is dramatic, featuring steep terrain and rocky bluffs rising as much as 600 feet in local elevation, where patterns of life correspond to the angles of slopes and the direction they face. Watersheds of rivers like the Root and Whitewater are finely dissected: eroded and down-cut over time to incise meandering, shade-filled valleys where spring-fed streams can run through winter.

Bedrock here is predominantly limestone, dolomite and sandstone largely formed beneath ancient seas between 500 and 350 million years ago, when this part of the continent was located at latitudes near and even below the equator. The character of this bedrock defines the landscape both above and below ground. Above, it offers outcroppings that provide

specialized niche habitats for plants and animals, as well as a foundation for native plant communities ranging from dry (sometimes called goat) prairie and oak savannas, to mesic hardwood forests, to globally-rare algific talus slopes. Below ground, these sedimentary rocks are readily dissolved by the weak acid in rainwater, creating networks of porous spaces, passageways and even yawning sinkholes where precipitation can race from the surface to groundwater with little filtering. This short transit time means that there are few secrets kept among land use, groundwater quality and the quality of emerging springs: a key reason for the area's environmental sensitivity.

Add to these the powerful influence of the Mississippi River. The Upper Mississippi River National Wildlife and Fish Refuge reaches from Wabasha, Minnesota to Rock Island, Illinois: all told, over 240,000 acres of floodplain habitat and 261 river miles. Should we need a reminder, the river's valley makes clear that, while recent glaciers missed this region, they still made their mark from the wings. The valley was deepened and its cliff faces scoured by great volumes of glacial meltwater, and fine windblown silt (loess) was carried here from surrounding lands in the period during and after glaciation. In Minnesota, one is never far removed from the handiwork of ice.

A view of the Mississippi River floodplain from Minnesota's Driftless Area
Photo by ColdSnap

The wartyback mussel is a state listed endangered species. This Mississippi River species is now rare and found only sporadically as the river flows through the Driftless Area.

Ross Hier

"By restoring these habitats, we could both benefit the snakes' reproductive success and reduce encounters, since the snakes are by nature secretive and typically not aggressive unless threatened."

JAIME EDWARDS, MN DNR Wildlife Biologist

MN DNR Wildlife Biologist Jaime Edwards (right) with a bullsnake and crew member with an eastern hog-nosed snake. Both snakes are residents of the Driftless Area. Photo by MN DNR

Hard-Earned Magic

The Driftless Area is celebrated in arts and literature as a magical place, and so it is. But it's not an easy magic. It's earned through conscious decisions and actions. For the Nongame Wildlife Program and its many partners working to conserve the natural heritage of the Blufflands region, it calls for insights rooted in research, persistence and first-hand knowledge of the land. It helps to have an intrepid nature and a decent pair of boots.

"Terrain is the biggest difference," says Jaime Edwards, who spent 18 years in the Driftless Area for the Nongame Wildlife Program and continues to partner with the program on projects in her current role as manager of the Whitewater Wildlife Management Area (WMA). "The habitat types may occur elsewhere, but the steep terrain here sets it apart. It means that road access to many sites is limited. If you're doing restoration work, such as clearing invasive cedars from a bluff, it's often done on foot and by hand." The landscape is also fragmented into smaller parcels than in many parts of the state, the vast majority in private ownership. "So, even a relatively small project here may involve a working relationship with three or four landowners," she notes.

Much of Edwards' work in the Blufflands has focused on the timber rattlesnake, a state listed threatened species in decline due to habitat loss, illegal collecting and outright efforts to eliminate them. Over the years, these threats have been mitigated to a degree by restoring the bedrock bluff prairies and rocky outcrops that serve as den sites on both public and private lands. Says Edwards, "We'd get calls that they were showing up in yards, and people didn't want them around their pets or kids. We realized that the reason the snakes were moving down into these areas is because the bluff prairies they would normally stay on for a large part of the year were overgrown with trees or other woody vegetation. By restoring these habitats, we could both benefit the snakes' reproductive success and reduce encounters, since the snakes are by nature secretive and typically not aggressive unless threatened."

Initially, there was some concern that snakes—in particular, gravid (pregnant) females—might move off sites as a result of work in the area, bolting when they emerged after winter hibernation to find their surroundings altered. But post-restoration studies documenting numbers of snakes and their age-classes at den sites indicated that they remained in the vicinity and successfully gave birth to young.

Projects have evolved over time as other wildlife species have been found to occupy these same spaces. In addition to timber rattlesnakes, management now takes into account the interests of splendid tiger beetles, Leonard's skippers, six-lined racerunners, five-lined skinks and a host of other Species in Greatest Conservation Need.

A relationship with a landowner often begins with a knock on the door. If an area looks promising for priority species based on information in the Natural Heritage Database or aerial photos, Nongame Wildlife Program staff ask permission to walk the property and evaluate habitat. "Afterward, if we've been invited on the land, we'll give them a copy of the survey sheet documenting native plants and wildlife we've observed, along with our overall assessment of existing or potential habitat," says Edwards. "Their response is often, *'Wow, I didn't know I had all this stuff!'* There are situations where it's appropriate to keep locations of rare species under wraps for their protection. But we've tended to be very upfront with landowners. In my experience, when they learn they have something special on their property, they have more of a protective attitude."

The landowner is informed if their land meets criteria for assistance with restoration work. This might include management plans, removal of invasive cedars, use of grazing goats to knock back brush, prescribed burns, inter-seeding of native species and other measures—all subject to their agreement. "It's a conversation," says Edwards. "We'll ask, *'How about this, is this acceptable? This would meet our goals. Would it meet your goals?'* We've had so much landowner cooperation that we've been able to expand and build on it, make it more of a landscape effort, mapping polygons that enable us to view sites as part of a complex with connectivity."

For practical purposes, not every site is considered redeemable through restoration. For example, if a look back on historic aerial photos shows that a bluff prairie has been closed in since the 1950s, the transition to forest may be irreversible. "But if it was open in the 50s and closed in the 90s, there's still a chance of getting it back," notes Edwards.

As their name suggests, timber rattlesnakes do use forested areas. But den sites on rocky outcrops in bluff prairies are recognized as critical habitat and are a key focus of restoration.
Photo by Jeff LeClere

Diverse Region, Diverse Strategies: A Selected Sampling

High, rocky bluffs are an iconic landscape feature in the Driftless Area, but they represent only one facet of the Nongame Wildlife Program's efforts in the area. At any given time, initiatives in various stages and diverse ecological settings are underway as program staff collaborate with in-state partners as well as agencies in neighboring states.

While nature operates on its own time frame, work plans must be designed to follow grant and budget cycles, gearing up (or down) according to funding. State Wildlife Grants, Competitive State Wildlife Grants and the Lessard-Sams Outdoor Heritage Fund (created by the Clean Water, Land and Legacy Amendment) have been key funding sources making this work possible.

In fragmented landscapes, careful planning is needed to conduct prescribed burns without causing undue mortality to invertebrate populations that may be present as adults and larvae. Strategies to minimize potential harm include careful timing of burns, and burning on a rotational basis, leaving some areas unburned to serve as refugia.

"Whitewater WMA is my favorite place on earth," says invertebrate ecologist Jessica Petersen with the MN DNR Minnesota Biological Survey. "There is **insect diversity** that exists there that no longer exists elsewhere in the state. It's outstanding." Petersen has been among those conducting **targeted surveys** for Lepidoptera (butterflies and moths) at multiple locations, documenting Leonard's skipper and regal fritillary—both state listed Special Concern species—at the Weaver Dunes Complex and Whitewater WMA.

MN DNR Minnesota Biological Survey Entomologist Jessica Petersen conducting surveys in the Driftless Area
Photo by Mike Worland, MN DNR

Leonard's skipper
Photo by Jessica Petersen, MN DNR

Persius duskywing
Photo by Kyle Johnson, MN DNR

Dusted skipper
Photo by Jessica Petersen, MN DNR

Better represented in neighboring Wisconsin, the Persius duskywing is a state listed endangered species at the edge of its range in Minnesota, where it has likely always been rare. In contrast, the Leonard's skipper (a state listed species of Special Concern) and the dusted skipper (a state Species in Greatest Conservation Need) were once more widely distributed in the state but have grown increasingly rare with loss of habitat. All are specialists of oak savanna and sandy barrens, communities in the Driftless Area that benefit from fire.

"Among native bee species in North America and Hawaii with sufficient data to assess, more than half are declining, and nearly one in four is imperiled and at increasing risk of extinction."

POLLINATORS IN PERIL,
the Center for Biological Diversity

Rusty patched bumble bee
Photo by Heather Holm

Pollinators continue to command attention in the state and country, due to widespread population declines. In addition to securing data on the **federally listed rusty patched bumble bee**, Nongame Wildlife Program surveys provide a window into the status of pollinators generally. For example, nine species of bumble bees were documented at Whitewater and McCarthy Lake WMAs, while a survey at the Weaver Dunes Complex revealed a diversity of native bee species from a range of morphological groups, including but not limited to **chap leg bees, striped sweat bees, hairy belly bees** and **cuckoo bees**. While lesser known, these species perform critical functions in Minnesota's natural landscapes, gardens and agriculture-based economy. Survey results inform management and planning. In one project, over 500 acres of sand prairie, oak barrens, savanna and oak woodland have been restored to **improve pollinator habitat** on public land in the Whitewater WMA. Post-restoration monitoring documented increases in populations of pollinators as well as their nectar and host plants, both indicators of success. A joint effort with Wisconsin's DNR has also worked to benefit pollinators through development and promotion of **Best Management Practices** shared with the public in workshops and one-on-one contacts.

The region's wetlands and dry sand prairie have also been recognized as important habitat for the **Blanding's turtle**, a state listed threatened species. Recent work here has focused on efforts to inventory current adult and hatchling populations and compile historic data from multiple sources to better determine trends. This work is urgent, given that experienced observers have estimated a decline of as much as 70% in the past 10-15 years.

"Habitat is not always the primary limiting factor," says MN DNR nongame wildlife researcher Krista Larson. Poaching is a known problem, and efforts are being made to step up enforcement of this federal crime, which is subject to prison time. Recent prosecutions will hopefully send a message. "It's a source of frustration, since loss of even a few reproductive-aged females can have a dramatic impact," says Larson.

MN DNR Nongame Wildlife Researcher Krista Larson with a Blanding's turtle hatchling
Photo by MN DNR

While the species can be long-lived (70 years or more), Blanding's turtles don't reach sexual maturity until about 12 years of age, and studies indicate that predation can impact more than 90% of nests. Hatchlings and adults also experience tremendous mortality on roads when traveling between wetlands and nesting sites. Over the course of **roadside surveys** in fall of 2020, Larson and fellow biologist Mike Worland reported over 30% of total hatchlings observed as dead on the road, presumably hit by cars. Turtle crossing signs help to alert drivers, but "turtle tunnels" used successfully elsewhere are not practical in settings here, where activity is dispersed over larger areas. "The hatchlings are so tiny; they look like a piece of gravel. So, I understand it can be unintentional," says Larson. "I've actually been very encouraged by people in Driftless Area communities that I've met over the last couple of years, seeing how far things have come, in terms of the ways of thinking."

She recounts, in particular, a gentleman who was grading a gravel road using his own equipment, a pick-up with a rake loaded down with rocks. "Unfortunately, it happened to be one of those days when reptiles were really on the move. There were hatchling Blanding's, western hognose snakes, painted and snapping turtles. I'm running all over trying to get them off the road, thinking of how many were about to be killed. He stopped to talk and was so receptive. He knew about the turtles. He said they were not out that day, that he'd been keeping an eye out. My hands were holding turtles I had just pulled out from in front of his vehicle. He'd never seen a hatchling and had no idea they were so small. He asked to hold one and was clearly moved. He said, 'You know what, this road doesn't need to be graded today. I'll come back. Tell me when it will be a better time.' That meant a lot."

On the near horizon, the Nongame Wildlife Program is looking to partner with the Minnesota Zoo using telemetry and GPS data loggers to track Blanding's turtle movements and answer questions about how they utilize the landscape, similar to work elsewhere with wood turtles.

"I've actually been very encouraged by people in Driftless Area communities that I've met over the last couple of years, seeing how far things have come, in terms of the ways of thinking."

KRISTA LARSON, MN DNR Nongame Wildlife Researcher

Prescribed goat grazing is a tool to introduce disturbance.
Photo by Mike Worland, MN DNR

Disturbance is key to fire-dependent communities such as oak savanna and bluff prairie, which offer critical habitat for many Species in Greatest Conservation Need. Fortunately, there are willing recruits available to assist. The strategy for Mound Prairie State Natural Area and the Hammel, Kronseder and Wetbark State Forest Units calls for repeated seasons of **prescribed goat grazing followed by prescribed burning**. Paddocks are used to both contain the goats in sites targeted for grazing and, equally important, **to exclude their access to more sensitive areas** within those sites. Sandy rock outcroppings are off limits: they are attractive to goats but prone to erosion. Private contractors from the local community play an important role in renting out goat herds for this purpose.

A four person **strike team** led by Autumn Jensen can be called upon when time is of the essence, thanks to a **partnership with The Nature Conservancy** on a competitive federal grant for wildlife. The team is

equipped to take on a wide range of tasks on short notice: bolstering staffing levels for a prescribed burn or acting on early detection of invasive species with a rapid response before they get established.

The Nature Conservancy (TNC) has identified the Driftless area as part of its "**Resiliency Connected Network**," based on a national analysis identifying areas likely to be more resilient in the face of climate change. TNC Projects Manager David Ruff is based in the area and is working to establish connectivity of habitat complexes in places like the South Fork of the Root River and Rushford/Rush Creek. "The idea is to do the best work we can in the right places to maximize resiliency of natural systems for the future," says Ruff. There is abundant opportunity for collaboration with the Nongame Wildlife Program where such efforts dovetail with the aims of Minnesota's Wildlife Action Plan, which recognizes **climate change as a stressor of wildlife** and aims to increase connectivity to build resilience.

Prescribed burning is another disturbance tool to promote ecological balance.
Photo by Jaime Edwards, MN DNR

> *"The idea is to do the best work we can in the right places to maximize resiliency of natural systems for the future."*
>
> **DAVID RUFF, TNC Projects Manager**

Nongame Wildlife Program Technician Barb Perry, now retired, remains passionate about protecting rare species of the Driftless Area after many years of hard work in the field.
Photo by MN DNR

Continuity Matters: for landscapes and for people

Like Jaime Edwards, Barb Perry has focused on southeastern Minnesota for many years, starting in 2001 as a technician with the Nongame Wildlife Program, devoting half her time in the Driftless Area, then full time after 2016. Retired in spring of 2022, Perry leaves with memories as rare as the species she's worked to help. She recounts an experience scaling a bluff with an antenna in one hand, a receiver on a strap worn over the shoulder beeping stronger as she grew ever closer to an unseen rattlesnake, finally spotting it a foot away, nearly invisible in leaf litter with its cryptic coloring.

"It wasn't moving. It felt very safe," she laughs.

She's grateful to the landowners she's come to know, whose land she's walked and helped to restore. She knows that whoever comes next will need to tackle some of the same sites. "It's great when our work opens up that habitat and gives the native forbs and grasses a chance again, to bloom, to occupy that space. There can be such diversity there. But you also find out what else has been waiting in the soil to express itself, to fill in that opening that we've created. If you cut a cedar, it won't come back, but you may get invasive buckthorn, honeysuckle, bittersweet. Preserving these places is going to require ongoing investment."

Among the greatest imperatives for the program here is building the capacity to sustain these existing relationships while responding to new requests. "This is the most bio-diverse region of the state," says Perry. "The good news is that there is all this interest from landowners, including landowners who would love to do more work on their property and others who meet the criteria and want to participate."

Generations of families have already lent their own sweat and elbow grease to this work. Jaime Edwards says, "People get their kids and grandkids involved. It's been so many years, we'll see them now, all grown up, and they'll tell us, 'I remember when I came out and helped with that prairie.' It's been a privilege to share these experiences with people, and rewarding to see the progress they've had with their management goals."

To hear Perry and Edwards talk, it's clear that this is not about people just doing a job. It's their passion, their life's work. The relationships they've built with landowners are grounded in mutual respect and shared appreciation for the conservation values they've worked together to preserve.

It's some of the best magic in the Driftless Area.

KEN VISGER, landowner

"I've been tromping around these hills a long time. We moved here in 1974, and it's been an evolving process. I was a part-time farmer, worked in town, had cattle. I wasn't really focused on conservation and habitat; it was all about growing crops. I was first introduced to the MN DNR Nongame Wildlife Program efforts when I met Jaime Edwards. She'd heard we were having issues with rattlesnakes in the yard and suggested that we create better habitat for them up in the hillsides behind the house, which was covered in Eastern red cedar. It seemed counter-intuitive, to restore habitat for snakes when you wanted to see fewer snakes. But we went for it. She hired a local forester, Johnny Micheel of Chimney Rock Forestry, who spent all winter long clearing and burning cedar off of 80 acres. It worked. In the 12-15 years since then, we've seen two snakes, and we had been getting three or four every summer. Since then, with Barb Perry as well, the program has helped with prescribed burns, hired goats, a lot of buckthorn and invasive treatments. For me as a landowner, having that resource available has been just wonderful.

"Soon after that first winter when Johnny did his clearing work, I quit farming, got rid of the cattle. Now, I'm spending all my energy trying to restore my property back to what it should have been from the beginning. It's become more important to me to restore the prairie where I can, and to manage my forest land.

"When I was younger, I had an interest in the outdoors, but I thought of it more as a playground. It took me until I was in my 50s to understand the tremendous value of the Upper Mississippi Refuge and the Driftless Area. It's a unique landscape and resource, and a real asset to the state of Minnesota. I think nongame work should be better appreciated and better funded than it is. I'm a hunter and fisherman—that's how I learned to love the outdoors. But without nongame species, the game species wouldn't be there either, you've got to have the whole package."

Ken Visger and his wife, Terry, have 184 acres near Hokah. The Nongame Wildlife Program first surveyed the property in 2008, and began removing cedars in 2009. Over the years, there have been multiple contracts for restoration work on the property, and the Visgers decided to enroll the land in two different programs: a MN DNR Prairie Bank Easement for the bluff and woods/ savanna as one drives into the home site, and a conservation easement with the Minnesota Land Trust for the remaining acreage.

LUCILLE CROW, landowner

"I'm the fourth generation to own the farm. It has been in my lineage for 168 years. After I inherited the land in 2005, I was thinking of things I might like to do. I decided to lease part of the land to a cousin who farms, which helps pay the taxes. A neighbor said, you know, maybe I might want to get in touch with Prairie Moon Nursery. Prairie Moon was overjoyed to lease 15 acres, where they plant wildflowers that need sandy soil. So now, in spring, we get to see this beautiful swath of sky-blue lupine. It was an arborist with Houston County who encouraged me to get in touch with Jaime Edwards and the Nongame Wildlife Program, since there were 20 acres or so of pasture that had never been cropped. She and Barb Perry came out and discovered many prairie plants in the pasture, and then up on the bluff there were pasque flower and tons of native plants that none of us had seen before: goat prairie, they called it. It's been a wonderful learning curve for me and my family.

"The habitat management work has largely focused on getting rid of invasive species. I had thought at first that it might look like a park afterwards, but I can't say it matches what I had imagined. It's better. It's better because it's teeming with wildlife. We're seeing more butterflies, more birds. The whippoorwills have come back. My sons and I now pay attention to the new growth in the areas where work has been done.

"In communities like this, it tends to be word of mouth. Jaime and Barb are authentic. They have the ability to meet a farmer, discuss what they do, open the door to possible solutions they could offer. I so appreciate them, and the Nongame Wildlife Program, for providing the means to restore the prairie and savanna on our farm. No, it's not a park. It's nesting habitat. It's a place where things live."

(Photo, right) Lucille Crow's 260-acre farm is near Rushford. The Nongame Wildlife Program has restored oak savanna on 22 acres through brush mowing, and removed cedar/invasives on 10.5 acres to restore bluff prairie. Prescribed burning and grazing goats have been used in both locations.

Photo by Richard Hamilton Smith

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TRACKING PRAIRIE VITALS

VALUABLE DATA FOR THE PRESENT AND FUTURE

"The data sets are outstanding; it's really a great pool of data," says Rhett Johnson, MN DNR Scientific and Natural Areas ecologist.

Back in 2008, that pool of data was still just an idea. Here was the basic concept:

Create a small working group that includes partners from the U.S. Fish and Wildlife Service, the Minnesota Department of Natural Resources and The Nature Conservancy—three entities that own or manage land harboring the majority of the state's protected native prairie, nearly 120,000 acres. Set up a system for long-term monitoring of these prairies, defining one or more permanent transects (study areas) per site. Develop standardized monitoring protocols that will make it possible to assess change over time at any given site and also make "apples to apples" comparisons between sites. Agree on a set of criteria that can be tracked as indicators of ecological health, such as the percent of native prairie vegetation relative to non-native/invasive species and various measures of biodiversity. Send out trained field ecologists to monitor vegetation along the transects at regular intervals.

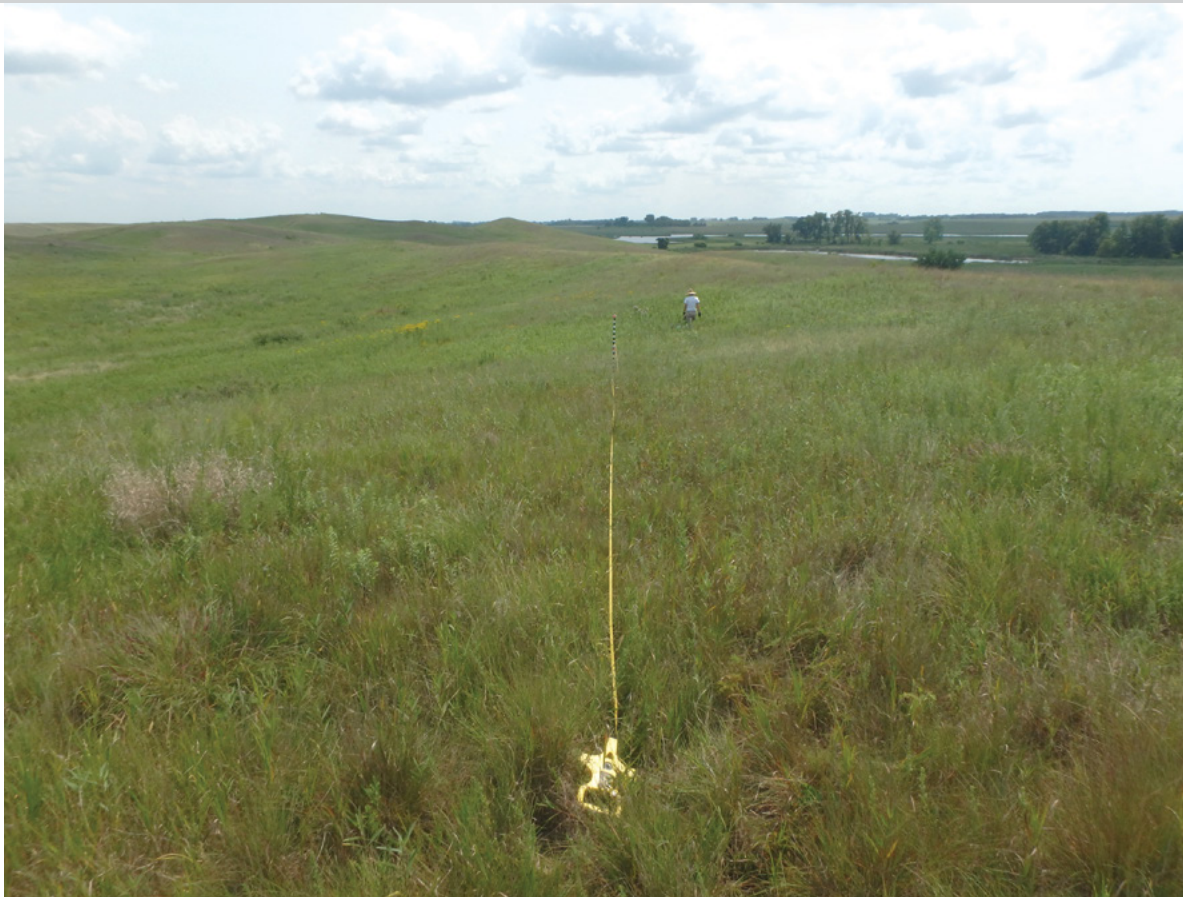
July prairie colors at Glacier Lake State Park
Photo by Richard Hamilton Smith

Enter information into a common database that will be available to all. Design models for data analysis that will enable you to ask good questions and get good answers. And here's the kicker: you accept that doing it right will take a while.

At the close of 2021, roughly 13 years later, that digital archive held accumulated data on 2,344 transects within 298 management units defined on 100 unique native prairie sites. That included 263 transects (roughly 11% of the total) located on protected prairies in the eastern Dakotas. In total, over 27,000 acres of native prairie have been monitored. By now, these numbers have likely increased.

The monitoring is exacting, labor-intensive work. Trained field staff visit sites, using GPS coordinates to confirm locations of transects. Completing the basic protocol can take 45 minutes per transect, while an optional—more sophisticated—protocol can take three to four hours per transect.

Surveyors assess diversity in the structure (e.g. height, density) and type of vegetation (e.g. percent grasses versus forbs, degree of encroachment by woody plants). They also document the presence of selected "Tier 1" native species that indicate a quality prairie, such as pasque flower and purple prairie clover.



Data collection underway across a transect in Glacial Lakes State Park
Photo by MN DNR

Standardized monitoring protocols make it possible to assess change over time at any given site and also make "apples to apples" comparisons between sites.

Purple prairie clover indicates quality prairie, which helps support some of Minnesota's more that 500 bee species, such as this *Eucera* long-horned bee.
Photo by Jessica Petersen, MN DNR

Pasque flowers
Photo by ColdSnap

It's work that Johnson, who has personally monitored more than 30 sites, many repeatedly, enjoys. "I like the quiet," he says. Moving slowly along a transect focused on his task, he's often had wildlife come close—a sedge wren singing from its perch, a mink that "came right up and looked me in the eye." Multiply his work by that of dozens of others monitoring sites over the years, then add the data management and coordinating tasks shared by partner organizations, and you begin to get an idea of the scope of the effort.

Such a tremendous investment of time, energy, expertise and resources naturally begs the question: to what end?

SPICE: Sustaining Prairies in a Changing Environment

"The beauty of this data is that it can serve different objectives for each user, now and in the future," says Daren Carlson, research scientist with the MN DNR's Nongame Wildlife Program. "At the start, we were very intentional about developing research with both short- and long-term benefits in mind." Carlson was in on the ground floor of the monitoring initiative's inception and leads a related MN DNR project dubbed SPICE, for Sustaining Prairies in a Changing Environment. SPICE investigates long-term trends in data from a subset of 40 of the monitored sites, aiming to tease out any changes in high-quality prairies due to habitat fragmentation and climate change. By design, some of the 40 sites are large and embedded in a landscape of grasslands, while others are small and isolated. Sites are scattered geographically (see figure 1) to capture potential differences in climate change effects due to latitude.

The SPICE initiative includes a special focus on grassland birds, with annual point-count surveys from established locations within the prairies. To enhance our understanding of these complex systems, plans are underway to add surveys of pollinators which serve critical ecological roles yet may respond differently to habitat management than birds. This kind of "status and trend" research is by its very nature a long game. Thus far, investigators have not observed major trends in vegetation attributable to climate change or habitat fragmentation. "That's not surprising," says Carlson, "since 13 years is a short time frame for the prairie ecosystem." But one facet of SPICE—the monitoring of grassland birds—has recently produced some striking results.

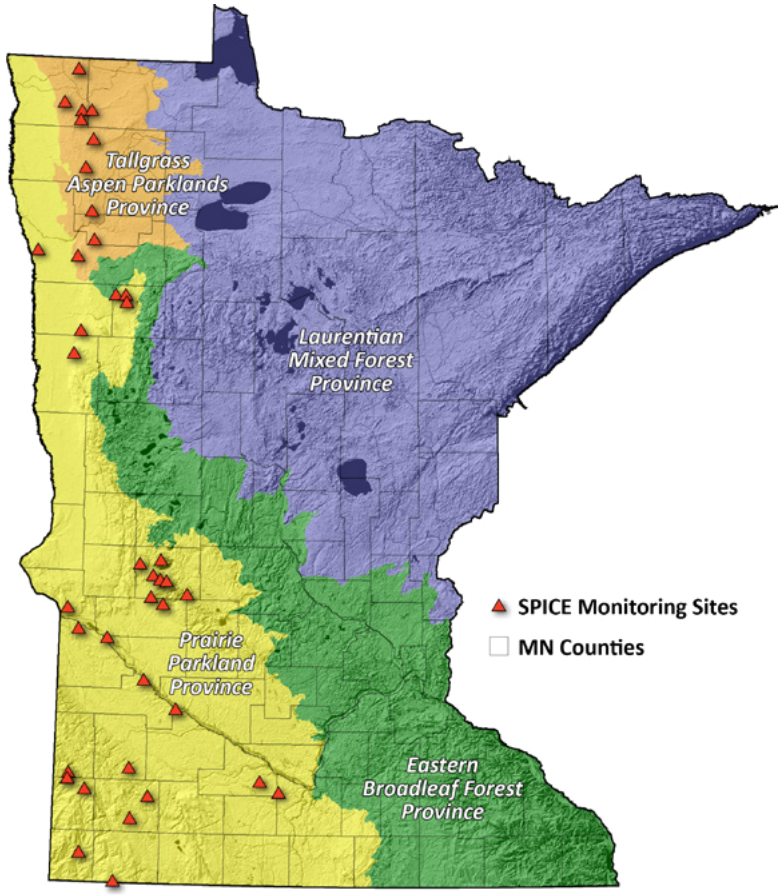


Figure 1. Distribution of monitoring sites

"Status and trend information is akin to personal vital signs—a barometer of the state of our natural world," says Nongame Wildlife Program Research Scientist Daren Carlson. Carlson has played a key role in both SPICE and the Grassland Monitoring Team.
Photo by MN DNR

List of grassland bird species tracked at the 40 SPICE sites. Species not observed are Sprague's pipit, Baird's sparrow, and longspur.

Eastern meadowlark
Western meadowlark
Gray partridge
Ring-necked pheasant
Sharp-tailed grouse
Greater prairie chicken
Northern harrier
Swainson's hawk
Killdeer
Sprague's pipit
Upland sandpiper
Marbled godwit
Wilson's phalarope
Short-eared owl
Horned lark
Sedge wren
Clay-colored sparrow
Vesper sparrow
Lark sparrow
Savannah sparrow
Grasshopper sparrow
Baird's sparrow
Henslow's sparrow
Le Conte's sparrow
Chestnut-collared Longspur
Dickcissel
Bobolink

It's an aspect of the project that Nongame Wildlife Program biologist Mike Worland knows well. Worland has been conducting surveys for grassland birds at the SPICE prairies since the 2016 field season. Four of the 40 sites are surveyed annually, while the remaining are monitored at six-year intervals. Since the project's inception in 2008, every site has been surveyed at least twice. For Worland and his predecessors, it's been work that requires a particular skill set. Most birds are identified by their songs and calls rather than by sight, and surveyors must learn to distinguish individual birds based on location, distance and subtleties in their vocalizations to avoid double-counting.

Among the study sites, Worland especially appreciates Santee Prairie Scientific and Natural Area, a large prairie where he has heard a greater prairie chicken, and Glacial Lake State Park where, he says, "you can stand in the middle of the park and see nothing but prairie from horizon to horizon." Like many of us, he's aware of the concerning declines in populations of North American birds in recent decades, which have been widely reported in peer-reviewed publications like Science magazine as well as in the popular press. As a group, bird species that breed in grasslands have been hit especially hard, experiencing population declines of an estimated 53% since 1970.

Since the subset of prairies monitored by the SPICE project include many of the highest quality tallgrass prairie remnants in Minnesota, it stands to reason that grassland birds are faring better at these sites than in statewide breeding bird surveys that include more marginal sites.

Except for the fact that, as it turns out, they're not.

Glacial Lakes State Park in June
Photo by Mike Worland, MN DNR

Nongame Wildlife Program Biologist Mike Worland, holding a longhorned beetle
Photo by MN DNR

Declines of about 3% per year have been observed in Western meadowlarks, with greater declines on smaller, isolated sites than on larger sites.
Photo by Bob Dunlap, MN DNR

A recent review of the past 13 years of SPICE bird data found serious declines in many grassland bird species. The western meadowlark, an iconic species that, according to Worland, is known to "perch on top of structures like fence posts and sing its loud, clear, beautiful song," is still relatively common. "But we've observed a decline of about 3% per year for western meadowlarks and savannah sparrows in our project—greater on smaller, isolated sites than on larger sites." Other species have experienced even steeper declines on the SPICE sites. Grasshopper sparrows and upland sandpipers are declining 7% per year. "That might not sound like much, but you need to realize that, at that rate, half of that population is gone in 10 years. It tells us that it's not enough to build refuges within the state to protect these birds," says Worland. "Clearly, we need to think at much larger scales."

Worland hopes that awareness of the findings fuels action. He recalls the recovery of the Kirtland's warbler, a species he studied earlier in his career. When it was learned that the Kirtland's warbler would successfully breed in pine plantations, this federally listed endangered species—which was down to some 200 breeding pairs—began to recover. In 2019 the Kirtland's warbler was removed from the federal

list of threatened and endangered species. "We all need a livelihood," he notes, "and we all need to eat. It may be that part of the solution for grassland birds lies in grass-based agriculture—perennial crops that extend the habitat value of these refuges and also have benefits for people, like a source of income, better water quality and water storage. That could be their path to recovery."

In a 2017 paper published in BioScience (see Selected Resources), Brent Hughes and fellow investigators assert that studies of long duration "are essential to characterizing how and why nature is changing." When compared to studies of shorter duration, they are disproportionately cited in scientific journals, suggesting that they are foundational to the creation of new knowledge and more likely to inform societal and political decision-making. They "allow us to better understand the inherent variability of natural systems, to discern trends and shifting baselines and to witness rare events and unanticipated ecological surprises." The authors note key attributes of well-designed long-term studies, including consistent protocols, rigorous documentation, and having both basic and applied purposes: that is, obtaining knowledge as well as putting that knowledge to work.

Grasshopper sparrows are declining 7% per year.
Photo by Mike Worland, MN DNR

"It tells us that it's not enough to build refuges within the state to protect these birds. Clearly, we need to think at much larger scales."

MIKE WORLAND,
Nongame Wildlife Program Biologist

Informing management: The Grassland Monitoring Team

The Grassland Monitoring Team is another project that relies on this growing archive of data on Minnesota's prairies, making a big contribution on the applied side of things. Core members include Sara Vacek of the U.S. Fish and Wildlife Service and Marissa Ahlering of The Nature Conservancy (TNC), along with Daren Carlson of the Nongame Wildlife Program. While the Grassland Monitoring Team and SPICE share larger goals of prairie conservation as well as some personnel, the Grassland Monitoring Team takes a distinctly different approach.

The Grassland Monitoring Team supports the efforts of site managers with real-time information when it counts. Partners analyze monitoring data, track management practices undertaken and—through computer modeling designed for this purpose—generate management recommendations tailored to individual sites, projected out three years. Should you burn a particular native prairie next year? Should you graze it? Should you let it rest for a few years without any disturbance? Or would a combination of these increase the likelihood of the desired outcomes for ecosystem health?

For TNC Land Steward Eric Hoff, who is one of those managers, this is welcome insight. "I can tell you this: when I can get a management recommendation for a particular site from the Grassland Monitoring Team, I use it." Hoff is charged with the responsibility of making management decisions related to 25,000 acres of protected prairie in the Agassiz Beach Ridges landscape of northwestern Minnesota, along with a few sites across the border in North Dakota. These lands hold some of the best prairie in the state and offer important habitat for grassland birds and other wildlife. Native prairies have persisted here in part because the sandy beach ridges left behind by ancient Lake Agassiz made for poor cropland.

"Winter is planning time," says Hoff. The prairies are dormant, migratory songbirds have departed and the waterfowl—ducks, geese, swans—have moved through for the season. "I'll be out fixing fence, or meeting with tenants to hash out a grazing plan, and will visit different areas to make some chicken-scratch notes on site conditions, evaluating whether we've met our objectives, especially in terms of controlling invasive species.

"Plans for the upcoming season are generally ironed out by March, but we're also looking ahead to the following year. Budget and staffing are big considerations in what we're able to accomplish." The smallest units that Hoff oversees are 40 acres in size, the largest are 6,000. "The Grassland Monitoring Team management recommendations are helpful because they're specific: 'pasture x is due for x.'

> *"The Grassland Monitoring Team management recommendations are helpful because they're specific: 'pasture x is due for x.' Sometimes, the recommendation is to leave it alone, let it rest for a few years."*
>
> **ERIC HOFF, Land Steward, The Nature Conservancy**

"Sometimes, the recommendation is to leave it alone, let it rest for a few years," he notes. The Team's analysis of long-term monitoring data has indicated that some of the highest-quality prairies benefit from less intensive management.

The Grassland Monitoring Team runs the model and publishes summaries of the data annually that are of broad interest to many managers, but site-level recommendations are issued only for prairies where ongoing monitoring of transects and reporting on management practices is done. As designed, it's power in numbers, a way to learn more and learn it faster than any single person could do on their own.

Eric Hoff (top left), The Nature Conservancy
Photo by The Nature Conservancy

Melissa Ahlering (top right), The Nature Conservancy
Photo by The Nature Conservancy

Sara Vacek (bottom), U.S. Fish and Wildlife Service
Photo by Fred Harris, MN DNR

Spring prairie at Glacier Lake State Park
Photo by Richard Hamilton Smith

The Grassland Monitoring Team's methodology puts it squarely in the realm of adaptive management. At its most basic, adaptive management is sometimes portrayed as doing what every farmer does: take note of what worked and what didn't work, then apply that knowledge to what you do next. But in the science of natural resource management, it means something else. "This is not trial and error," says Sara Vacek. "The model integrates variables that allow us to make a prediction about the condition of a given prairie, about what practices are most likely to bring it from one defined state to another. It's also different from a controlled study, in that we're learning from what managers *choose* to do (burning, grazing, etc.) without *requiring* them to do it. We learn whether they follow the Grassland Monitoring Team's recommendations or not, as long as the monitoring protocols are in place." The Nature Conservancy's Marissa Ahlering adds, "It doesn't replace a manager's own assessment based on their intimate knowledge of a site but, added to the mix, it reduces the uncertainty about what actions will bring about the desired result, which is a healthier prairie."

Both SPICE and the Grassland Monitoring Team offer broader insights into the northern tallgrass prairie ecosystem. They contribute to the scientific literature informing international efforts to preserve grasslands, complementing other long-term research in the state coming out of places like the Cedar Creek Ecosystem Science Reserve. "Grasslands are among the most imperiled ecosystems in the world," says Daren Carlson, "and there are things we can learn about them collectively through long-term monitoring that we can't learn any other way."

Meanwhile, the data keeps rolling in and the model is getting an update with the help of modeling, structured decision-making and adaptive management specialists. The door is always open to more collaborators. Like native prairies, many of the projects' complexities exist out of sight, but the benefits accrue to all, their value just increasing over time.

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THEY MIGHT BE GIANTS

SALAMANDERS ARE AMONG THE HEAVY LIFTERS IN MINNESOTA'S FOREST ECOSYSTEMS

"You could walk right past them and never know they're there,"

Andrew Herberg

Talk about a needle in a haystack. How do you inventory—much less, protect—a rare animal that is generally solitary, silent, 2-4 inches long, weighs in at less than 1.5 grams on a heavy day, and is most likely found *inside* a sphagnum moss hummock? As if that were not enough, place the hummock among other, virtually identical hummocks in small, isolated wetlands surrounded by mature forest. "You could walk right past them and never know they're there," says MN DNR Nongame Wildlife Program biologist Andrew Herberg. Of course, from the salamanders' point of view, that's just fine.

Herberg is speaking of the micro-habitat favored by nesting four-toed salamanders in Minnesota, as evidenced by the settings where surveyors have documented females with eggs. The wetland might be a seasonal vernal pool where snowmelt or rain gathers in the low spots of rolling glacial terrain, or the moat-like open water that rings a conifer swamp or other shallow, semi-permanent

Four-toed salamander on a hummock of sphagnum moss in Carlton County
Photo by Andrew Herberg, MN DNR

wetlands nestled within mature forests—but the sphagnum moss component is key. "The species is a real habitat specialist when it comes to nesting," says Herberg. Females migrate from overwintering sites to small wetlands where they typically lay their clutch of eggs within a hummock of sphagnum moss. A female will often stay with the eggs for at least part of their roughly 40-day incubation period, in many cases attending her own clutch of eggs along with those of others who "lay and leave." When the larvae hatch, they need only wriggle down the mossy slope of the hummock and drop into the open water below.

It's an exquisite life strategy, provided that the female has selected a well-placed hummock, and the water body isn't *too* ephemeral. "It can take roughly six weeks—we don't know precisely how long—depending on environmental conditions for the larvae to complete their development to the point where they become terrestrial," says Herberg. "So, the length of that hydro-period really matters. The water can't dry up too soon." When it happens, as it sometimes does, the opportunity to replenish the local population that year is missed. To persist, the species relies on redundancy: numerous wetlands distributed across its range where—over time—enough larvae meet with success.

"What we know about salamanders as a group is fascinating: and there is so much that's still to be learned about their abundance, basic ecology and habitat use here in Minnesota."

ANDREW HERBERG,
Nongame Wildlife Program Biologist

Nongame Wildlife Program Biologist Andrew Herberg holding an Eastern newt (pictured in its larval aquatic stage) which is designated as a Species in Greatest Conservation Need
Photo by Spencer Rettler, MN DNR

Ross Hier

Species shown, from top:

- Four-toed salamander
- Blue-spotted salamander
- Eastern red-backed salamander
- Eastern newt (juvenile, left, and aquatic adult, right)
- Spotted salamander
- Tiger salamander
- Mudpuppy

Temporary wetlands in forested settings are also vital habitat for another salamander species listed as Special Concern in Minnesota: the spotted salamander. The comparatively larger (albeit still less than 7" long) spotted salamander bypasses the transitional lodging in moss hummocks and deposits its egg masses directly in water. The spotted is considered a vernal pool obligate, explicitly depending on these seasonal water bodies, whereas the four-toed is a vernal pool "facultative" species, using them opportunistically but not exclusively.

It seems a risky business. Why would a species evolve to rely on temporary wetlands for reproduction? One likely factor is that larger, more permanent wetlands pose an even greater risk to amphibian eggs and larvae: the presence of predatory fish.

While the Nongame Wildlife Program works to sustain all eight salamander species found in the state (see inset), it prioritizes efforts benefiting designated Species in Greatest Conservation Need. They're a diverse lot that includes the little all-terrestrial red-backed salamander, along with three species listed as Special Concern: the four-toed salamander, the spotted salamander and the all-aquatic mudpuppy. The mudpuppy is the only known host for the larval form of the rare salamander mussel, a threatened species in Minnesota. Fishermen who make an accidental catch of a mudpuppy are encouraged to release them without delay. They are both harmless and beneficial.

Truth is, many people could count the number of encounters they've had with salamanders on no hands. The lives of these amphibians rarely intersect with ours, beyond the occasional individual that turns up in a window well or under an upturned log. Even on rainy nights when they sometimes stream like dark ribbons across country roads, they can easily go unnoticed.

It's high time we start seeing salamanders. They're owed some serious credit for the heavy lifting they do, despite their size. Gram for gram, salamanders are among the most efficient converters of bio-mass

in forest ecosystems. They consume high volumes of invertebrates (snails, worms, fairy shrimp) and convey much of that accumulated energy up the food chain when they become prey for larger mammals and birds. In their reliance on freshwater environments, they remind us of our own. Like waterfowl in prairie potholes, they are indicators of how well we are stewarding the state's natural resources—not only biodiversity but also the ephemeral ponds critical to groundwater recharge.

According to Herberg, who has been among those biologists in the field with water overtopping his boots, carefully peering through strands of sphagnum moss in search of four-toed salamanders, they're also just plain cool. "What we know about salamanders as a group is fascinating: and there is so much that's still to be learned about their abundance, basic ecology and habitat use here in Minnesota."

Herberg is excited to be leading the charge on a monitoring effort kicked off in 2022 focused on four-toed salamanders in the Laurentian Forest Province counties of Mille Lacs, Kanabec, Pine, Carlton, Cook, St. Louis, Aitkin and Itasca. "The main driver for the project is to ask: How are Minnesota forest management practices impacting four-toed salamanders?"says Herberg. Modeling efforts utilized historical locations of the species and associated habitat attributes to inform the process of defining sample plots across the study area for monitoring at a scale that will hopefully be able to detect changes in occupancy. The study utilizes a "Before and After Control Impact," or BACI, design, in which control plots (where forest management will not occur) will offer a basis for comparison to plots where forest management occurs. This calls for coordination with state forestry officials to know where and when harvests are planned within the study area.

Minnesota's salamanders

- Blue-spotted Salamander
  (Ambystoma laterale)
- Eastern Tiger Salamander
  (Ambystoma tigrinum)
- Spotted Salamander
  (Ambystoma maculatum)
  Special Concern and Species in Greatest Conservation Need (SGCN)
- Western Tiger Salamander
  (Ambystoma mavortium)
- Four-toed Salamander
  (Hemidactylium scutatum)
  Special Concern and SGCN
- Eastern Red-backed Salamander
  (Plethodon cinereus)
  SGCN
- Eastern Newt
  (Notophthalmus viridescens)
- Mudpuppy
  (Necturus maculosus)
  Special Concern and SGCN

Ventral patterning can be used to identify individual four-toed salamanders. Photo by Andrew Herberg, MN DNR

The issue of detectability factors into the number of plots monitored—that is, how likely surveyors are to be able to find a salamander that is present. “Little to no detectability data exists for this species, especially in Minnesota,” says Herberg, “Accordingly, a pilot year in 2022 focused on gathering baseline data to better determine the number of monitoring plots needed to detect changes in occupancy over time.”

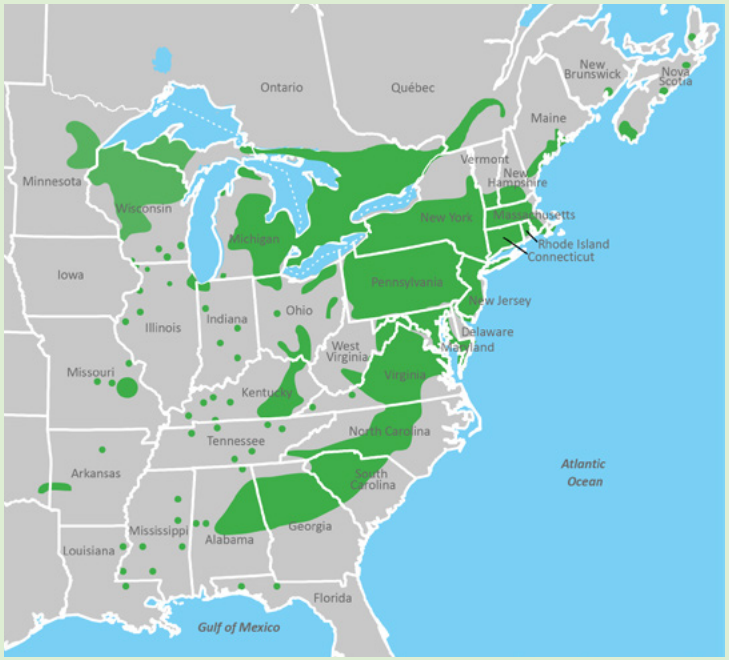
Monitoring (which included surveying for larvae during the pilot year) will be done for at least two years pre-harvest and two years post-harvest, and control sites annually. The varied land ownerships across the study area create welcome opportunities for future collaboration with the Chippewa National Forest, Fond Du Lac Band (pending), Leech Lake Band, counties, St. Cloud State University and other partners. It’s a truly massive undertaking that will not only offer insight into impacts of forest management practices on this rare salamander, but also metrics on nest selection, upland habitat use, and baseline occupancy data that will hopefully lay the groundwork for future long-term population monitoring.

In the midst of the study, slow and steady work continues to map the seasonal wetlands across the region that offer existing and potential habitat for the salamanders, using leaf-off aerial photography and LiDAR (Light Detection and Ranging) images followed up by ground-truthing in the field. Herberg is also excited about what can be learned through potential identification of individual salamanders using the patterning of their ventral (belly) sides, which, like fingerprints, appear to be unique. He is not alone in his enthusiasm. These salamanders definitely have their champions. Says Herberg, “The interest is out there, and the Nongame Wildlife Program is committed to these efforts. It’s labor intensive, so we’ll need sufficient staffing levels and funding to make the progress we’d like to make.”

It wasn't until 1994 and 2001, respectively, that the four-toed salamander and spotted salamander were even known to occur in the state. Carol Hall recalls those discoveries well. Hall is a herpetologist with the Minnesota Biological Survey, the MN DNR program tasked with the county-by-county survey of the state's native plant and animal species. "The four-toed was not even on our radar during surveys in central Minnesota, since the closest records were across the border in Wisconsin. We had just finished surveys in southeast Minnesota in 1993 where we thought it was possible we could find them but hadn't." Instead, the species unexpectedly turned up in a drift-fence bucket during surveys conducted in Itasca County, where the Minnesota Biological Survey was cooperating with the Chippewa National Forest documenting amphibians and reptiles within different Land Type Associations. "At first, we weren't sure what we were seeing," says Hall. "We had to look through a microscope to confirm that it had four toes on each of its hind limbs." (Minnesota's other terrestrial salamanders have five). As Hall relates, it was seven years later that the first record of spotted salamanders began as a promising egg mass in the Nemadji State Forest and was confirmed only after the eggs were collected and reared. The discoveries changed the range maps for these species. For example, Minnesota is now at the northwesterly edge of the four-toed salamanders' U.S. range (see figure 1).

MN DNR Minnesota Biological Survey Herpetologist Carol Hall

Figure 1. Four-toed salamander range map, showing Minnesota as the northwesterly edge for the species



Range map of four-toed salamander from Peterson Field Guide to Reptiles and Amphibians of Eastern and Central North America, Fourth Edition. 2016. Robert Powell, Roger Conant, Joseph T. Collins. Houghton Mifflin Harcourt, ISBN 9780544129979. https://commons.wikimedia.org/wiki/File:Hemidactylium_scutatum_map.svg

Nongame Wildlife Program Biologist Gaea Crozier and Specialist Cheyanne Rose survey for forest salamanders. Photo by Clara Brown, MN DNR

Subsequent surveys by the Minnesota Biological Survey documented additional occurrences of the four-toed in Itasca, Aitkin, Mille Lacs, Pine, Carlton and St. Louis counties, with a recent (2021) record by staff from the Chippewa National Forest extending the species' known distribution in the state to Cass County. The spotted salamander is thus far known to occur only in Pine and Carlton counties. "Surveys by the Minnesota Biological Survey generally assess presence of a species—not population size or viability—but records (which can consist of one or more individuals or egg masses) provide an index of relative abundance across counties," says Hall, "as well as locations where management practices or monitoring efforts can be focused."

Even in many areas of seemingly suitable habitat across their range, four-toed salamanders are rarely found, having a patchy distribution. Thus far, the same holds true here in Minnesota. "You can search one wetland after another, not finding them, but when you do, it's really a rush," says Hall. "You have this awareness of the entire community—that it's woven together with the wetlands, the upland forest and the sphagnum—all of that being necessary within a certain area to make that population viable."

Surveys have tended to focus on the wetlands where these forest salamanders reproduce, given the opportunity afforded by the window of time when females are on eggs. But conservation management requires a broader view, one that takes into account the needs of these species throughout the seasons and throughout their life cycles. This includes not only fish-free wetlands (with a sphagnum moss component for the four-toed), but also the adjacent forested upland habitats, where they are less often detected but where most of their lives are spent.

Four-toed salamander nesting habitat in North Central Minnesota
Photo credit Andrew Herberg, MN DNR

To serve as good salamander habitat, this upland terrain will have certain characteristics. Chief among them are coarse woody debris and leaf litter (for refuge and food sources), and a forest canopy that offers sufficient shade to moderate temperature and maintain moist conditions at ground level. At different scales of planning, other considerations come into play in promoting salamander survival (see inset), especially in areas of known or potential habitat for rare species.

Promote

- Closed-canopy, mature upland forest
- Coarse woody debris
- Moist soils
- Abundant leaf litter/duff
- Travel corridors offering connectivity between breeding sites and upland habitats, as well as opportunity for dispersal among breeding sites

Minimize/Avoid

- Herbicides
- Wide, high-use roads and trails
- Uses that cause soil compaction
- Erosion of sediment into wetlands
- Timber harvest or thinning that reduces original basal area by more than 20%

Four-toed salamander
Photo by Andrew Herberg, MN DNR

So, just how big is the universe of a four-toed or spotted salamander? What constitutes their home range, if they have one?

The scientific literature offers some insight. In their paper, *Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibians and Reptiles*, Raymond Semlitch and J. Russell Bodie summarized data from studies in multiple states to provide estimates of the biologically meaningful size of core terrestrial habitats used by local breeding populations surrounding temporary wetlands. For amphibians as a group, core terrestrial habitat ranged from 159 to 290 meters, with each figure being the radius of a circle with the wetland at its center. The area of these circles of core terrestrial habitat would therefore range from roughly 19 acres to 65 acres, respectively.

While not prescriptive—nor tailored to Minnesota's environment—such data offers a starting point for the area within which resource managers might make considerations for salamanders in the interest of promoting stable populations. The MN DNR's Minnesota Biological Survey has prepared a guidance document with management recommendations appropriate for sites having documented and potential use by rare salamanders. Ongoing research will continue to inform and refine that voluntary site-level guidance.

"As we think about the area to focus on for protective measures, 'life zone' is a far better term than buffer zone. It's the area where these species live, where they need to be able to satisfy all their life requirements," says Ed Quinn. Quinn has served as Natural Resources Program Supervisor for the MN DNR's Parks and Trails Division for over two decades. He also happens to have a special interest in—and knowledge of—salamanders, which were the subject of his graduate work in Northeast Ohio. In his role with MN DNR's Parks and Trails, he's had plenty of opportunity to take the interests of salamanders into account.

"You don't start with a blank canvas. You first identify the species that are there and their critical habitats, their life zone. Then, you have to think spatially as well as temporally—not only where impacts might occur, but when and how often." For example, he notes, a forest road or trail that salamanders must cross between upland habitat and their breeding site could be seasonally closed to reduce mortality. Soil compaction could be reduced by limiting vehicle use (including recreational vehicles) to times of year when the ground is frozen. With timber harvest, says Quinn, you need to seek a middle ground that protects enough of the local population before, during and after harvest.

"When canopy cover is reduced too much, one of the things that happens is that you have greater evapotranspiration out of these small wetlands, meaning they may not hold water long enough to support reproduction. And these salamanders are very philopatric—that is, tied to the pond they emerge from as larvae, tending to return there to breed. In our study in Ohio, we found salamanders returning to the site of a wetland that had been filled in, which was no longer there." The limited mobility of salamanders, along with their reliance on water bodies that are often isolated from others, makes such local populations vulnerable to collapse. "From the standpoint of species conservation, it's important to think at multiple scales, including the larger meta-population. There has to be suitable terrain between these small wetlands that makes it feasible for them to disperse and colonize new sites."

Ed Quinn is the Natural Resources Program Supervisor for the MN DNR's Parks and Trails Division and a salamander advocate.

"Life zone is a far better term than buffer zone. It's the area where these species live, where they need to be able to satisfy all their life requirements."

ED QUINN, Natural Resources Program Supervisor, MN DNR Parks & Trails

Female four-toed salamander guarding eggs in Pine County
Photo by Melissa Boman, MN DNR

"This kind of thinking is regularly put to use in planning for state Parks and Trails where," says Quinn, "our direction and statute require us to preserve and perpetuate the scenic, scientific, historic, and natural features that were present prior to European settlement." He cites the construction of passages for salamander migration under a newly constructed bike trail at Sibley State Park, and a life zone surrounding a wetland at Itasca State Park protecting terrestrial habitat from the impacts of an aspen harvest conducted to restore a pine-hardwood community. But the same basic ideas can apply more broadly. "A county road engineer has certain challenges, such as maintaining sight lines, elevations, safety. Yet, within those parameters, there are choices that can be made in the interest of amphibians like salamanders and other wildlife."

Quinn is thrilled at a recent endeavor involving the Minnesota Department of Transportation (MnDOT) that resulted in more wildlife-friendly erosion control materials and installation standards. "This was way more difficult than it sounds;" says Quinn, "it took us a couple of years to work through changes to the MnDOT specifications manual." Among the updates benefiting salamanders are a move away from use of plastic to more bio-degradable erosion-control materials and mesh with larger openings less likely to entrap reptiles, amphibians and small mammals.

Quinn's MN DNR Parks and Trails work—like that of the Nongame Wildlife Program—requires navigating between natural systems and societal systems, and positive conversations among resource managers who may have different goals uppermost in mind, reflecting the range of values important to the people of Minnesota. With a salamander species designated as Special Concern, protection calls for a good faith effort on all sides to find some literal and figurative wiggle room.

On a day when May leans toward June in Minnesota's north woods, Herberg is out in the field, moving from wetland to wetland, carefully following the protocols of the monitoring study. He's been part of many of those conversations.

As he works, he notes that the same vernal pools and surrounding mature hardwood forests that support salamanders are also important to a host of other species, ranging from wood frogs and spring peepers to dragonflies and red-shouldered hawks. He knows that this biodiversity is no accident. It is rooted in specific qualities that this landscape has to offer through the seasons, through the years. He also knows that these species are entering an era when older forests on state lands, like those that offer habitat to the four-toed salamander, will significantly decline if target levels for timber harvest in the coming decades are met.

During the 2022 field season, Herberg and MN DNR colleagues visited 29 study plots and surveyed 94 wetlands. One single hummock in Pine County, he says, held multiple females and hundreds of eggs—more than he had ever seen. When the circumstances are right and only when it can be accomplished without degrading habitat, he will gently handle a salamander just long enough to get a weight and length, and snap a photo of its ventral pattern. “When I put them back, it’s really neat to see them crawl back down into the maze of moss, slipping back into this hidden world.” Walking away from a site where they’ve been found, it’s a mixed feeling. “There’s a certain satisfaction and excitement, knowing that this rare species is using this wetland and surrounding forest. But there’s also some anxiety knowing I’m walking away from a wetland where, in most of these plots, we know the forest is going to be harvested. So, this wetland dynamic is going to change. And will that change to the point where these secretive little creatures are going to disappear? Or can four-toed salamanders tolerate the disturbance that is going to come?

Nongame Wildlife Program Intern Clara Brown assists with the search for four-toed salamander larvae.
Photo by Andrew Herberg, MN DNR

As the wetland dynamics in the forest change, will these secretive little creatures disappear?
Four-toed salamander in Carlton County
Photo by Andrew Herberg, MN DNR

"Honestly, the best thing that could probably come from this study is that we learn that current forest management practices aren't affecting their ability to occupy these sites. Or maybe we will learn that they're more common in Minnesota forests than we think. So far, the data doesn't point that way. But we'll find out."

While earlier surveys by the MN DNR Minnesota Biological Survey revealed that Minnesota's natural heritage was two salamander species richer than we realized, the Nongame Wildlife Program's current and ongoing monitoring will reveal what they need to continue to occupy the state's forests. Most important of all is a question whose answer is not to be found in moss hummocks—the question of how we will act on the knowledge gained.

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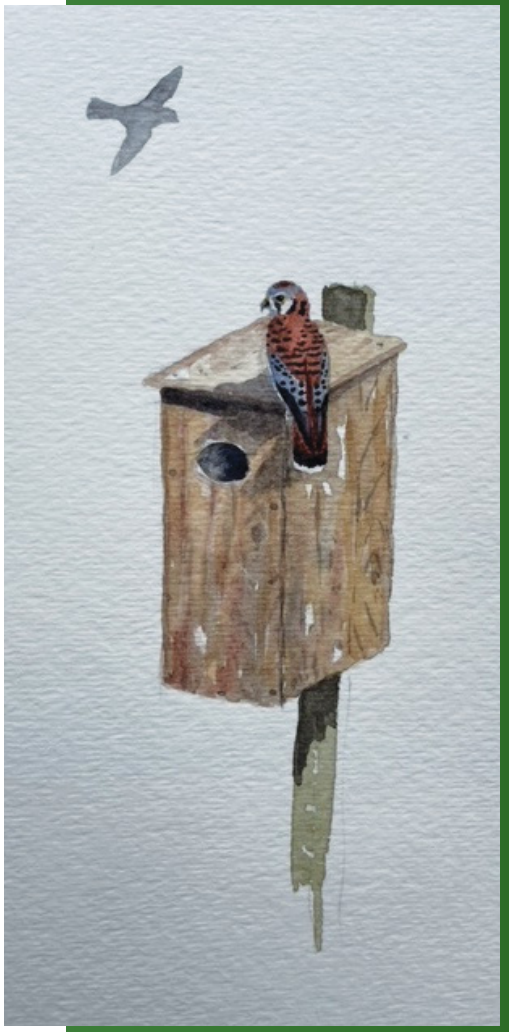

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