



A tract of northern mixed grass-prairie restored by a quarter-century of prescribed fire and intermittent livestock use at the Lostwood National Wildlife Refuge in North Dakota. Photo by K.Smith.

## Fire is for the Birds in Northern Mixed-Grass Prairie

### *Summary*

Roughly 25,000 acres of grassland in the National Wildlife Refuges of North Dakota and eastern Montana are treated every year with prescribed fire, mostly on northern mixed-grass prairie. Although this shrinking ecosystem is fire-adapted, there have been very few studies of the effects of prescribed fire on wildlife, introduced and native plants, and wildlife-habitat relationships in this delicate ecosystem.

For this project, researchers documented short- and long-term fire effects on abundance, productivity, nest site selection and nest predation in migratory birds, especially grassland songbirds. They also measured the impacts of encroaching woody shrubs and trees on breeding populations of common bird species and the manner in which the historic fire regime has shaped the type, distribution and structure of vegetation. Results indicate that native bird species are generally well adapted to frequent fires. Any loss of breeding habitat in the first post-fire season is more than made up for by the subsequent renewal of grasses and reduction in fuel loads. Nest predation appears to be short term. Lack of periodic disturbance by fire and grazing has allowed encroachment by trees, tall shrubs and invasive grasses, negatively impacting songbird breeding success and survival of native grasses. Informed use of prescribed fire enhances nesting success and abundance of grassland birds, sustains the native vegetation they require, and is essential for perpetuation of threatened northern mixed-grass prairie landscapes.

## Key Findings

- Broadleaf herbicides reduce the invasive forb knapweed, but also harm native forbs which are important components. Bird species native to northern mixed-grass prairie are well adapted to frequent fires.
- Proliferation of trees and tall shrubs negatively impacts populations of some bird species adapted to nesting in prairie grasses.
- Numbers of breeding birds and their nests decrease sharply after a prairie tract is burned, but they return to or exceed pre-burn levels in following years.
- Predation on songbird nests—for example, by deer mice—does not increase after burning.
- Short-term, post-fire loss of bird breeding habitat is likely outweighed by long-term benefits to vegetation structure.

## Disturbance desired: On the western front

Native prairie once covered nearly a quarter of the continental U.S., providing a home for specially adapted, diverse plant and animal life. Prairie ecosystems thrive on the intermittent disturbance brought by frequent fire and the irregular mosaic of vegetation carved out by the periodic passage of native grazers. These disturbances and subsequent renewal have shaped the life cycle of every native prairie organism.

But European settlement in the late 1800s and early 1900s brought vegetation changes, signaling the end of boundless prairie landscapes in the U.S. Farmers broke up the sod to plant crops, destroying ancient prairie vegetation and fragmenting what remained. Bison were replaced with cattle which graze differently. In addition, fire was excluded from much of the ecosystem. In less than a century, the vast prairie ecosystem was nearly eliminated, and native plant and animal populations declined accordingly. Invasive grasses and woody trees, shrubs, and introduced species of invasive grasses now out-compete native grasses in many areas. Breeding populations of most bird species that rely on grasslands have been significantly reduced.

There are three prairie ecosystem types in North America. Tall-grass prairie supports the iconic six foot high grasses and is found from southern Manitoba in Canada to western Missouri where there's more precipitation. Short-grass prairie extends from southeastern Alberta in Canada through eastern Colorado where the climate is much drier. Mixed-grass prairie lies between the two and has elements of both; tall grasses in low, moist meadows, short grasses on drier hill tops, and mid-height grasses in between. Most native prairie from South Dakota through southern Saskatchewan in Canada is considered northern mixed-grass prairie. It's estimated that less than 20% of North Dakota's northern mixed-grass prairie remains today, mostly in the relatively arid western region of the state.

Historically, fires swept the mixed-grass prairie every 4 to 5 years. Each blaze left a mixed mosaic of effects. Prairie grasses and forbs need about 3 years to mature, so the intervals between fires gave them plenty of time to resprout from their deep roots, grow to full stature, and burn again to continue the cycle. Prescribed fire has been used widely in restoration efforts across the northern Great Plains for 25 years. It rejuvenates the ecosystem by emulating

a natural ecosystem process. The fires remove dead vegetation and litter, reduce invasion by non-native plants, keep trees and shrubs at bay, and restore nutrient cycles.



Prescribed fire in the northern mixed-grass prairie at Des Lacs NWR North Dakota. Photo by D. Severson.

However, prior to this research there was very little definitive information specific to northern mixed-grass prairie about the comprehensive effects of fire on wildlife, native plants, introduced vegetation and the relationships between wildlife and their habitats. Most of the information was anecdotal, or was based on work done in other prairie types. Managers lacked the information they needed to predict impacts of prescribed fire. The timing, frequency and intensity of prescribed fires appeared to have varying effects and didn't necessarily enhance the ecological integrity of native mixed-grass prairie communities.

## Vegetation structure and grassland birds

The role of fire in mixed-grass prairie has been the focus of nearly two decades of study for Bob Murphy, former wildlife biologist for the National Wildlife Refuge (NWR) system in North Dakota, now a biology professor at the University of Nebraska-Kearney. Murphy and co-principle investigators Todd Grant and Elizabeth Madden, both U.S. Fish and Wildlife biologists for NWRs in the northern mixed-grass prairie, have been studying fire effects in this ecosystem since the concept of prairie restoration first took wing in the late 1980s and early 1990s.

Early studies focused on basic interactions between fire and nesting ducks. Scientists have since learned that the lives of grassland birds are intricately connected to the

structure of grassland vegetation: how tall it is, how dense it is, how much leaf litter and plant material are on the ground.

“If we know enough about the vegetation structure,” Murphy explains, “we can reasonably predict how birds are going to respond, which species will occur and what their abundance might be. But we wanted to know more about how fire influences nesting efforts by grassland birds, especially songbirds, including interaction with the woody vegetation that fire reduces. We also wanted to know more about how fire was influencing introduced plants because it’s all related.”

This project took place in four NWRs in North Dakota between 1997 and 2003. Researchers assessed direct and indirect, short- and long-term impacts of fire and fire exclusion on vegetation and wildlife population dynamics. Murphy, Grant, and Madden investigated how the presence or absence of fire affected several aspects of the lives of migratory birds—especially grassland songbirds. Specifically, they addressed how fire affected the quantity and variety of bird species present, how many nests were built and where, the survival of resulting eggs and nestlings and the impacts of nest predation.

### Little nests on the prairie

Murphy and his colleagues surveyed thousands of nests, which is no simple task. To find the tiny nests buried in the grass they used the tried-and-true rope drag technique: a researcher at each end of a long rope that they drag through the grass. They watch to see what flies up—and try to determine from where.



Researchers use the rope-drag technique to flush birds from the grass in the quest to locate tiny nests concealed in the vegetation. Photo by J. Derrig.

“It takes a lot of experience to be a good nest finder,” Murphy says. “My colleagues were experts and they taught the rest of us. You put in a lot of miles dragging that rope around and you obviously have to be very careful. Some of the bird behaviors around the nests can be incredibly effective at fooling you. They’ll flush away from the nest so you think that the nest is somewhere else.”

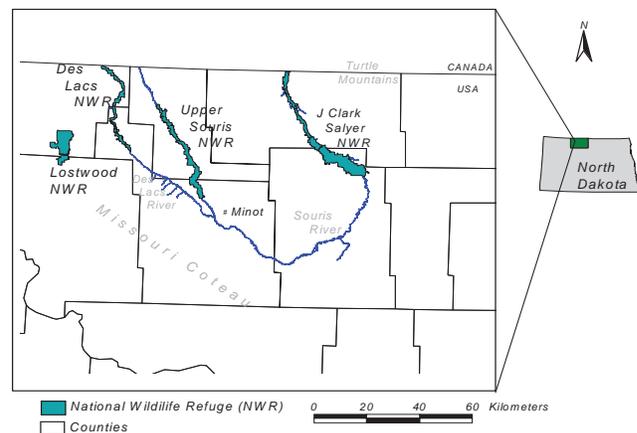
When they found a sparrow nest with eggs they “candled” the eggs to see how long they had been incubated. When they found a nest where the eggs had hatched, they estimated the age of nestlings. The trickiest part of the process, Murphy notes, is determining whether a nest is ultimately successful. A successful nest is one where the young survive to fledge.

“You really have to be attuned to what’s going on,” he explains. “The young leave the nest all at once and they’re very secretive. You never see a fledgling near the nest, so you have to rely on what you knew about the nest when you were there the day before—and the day before that. You look closely at what the parents are doing. They can give some strong cues to the presence of nestlings if you’re paying attention, but you have to really know how to interpret their behavior. If you do, you can make sound decisions about the final fate of those nests.”

In addition to their work with fire effects and grassland birds, they studied the responses and roles of small mammal populations in the overall post-fire picture. They also developed predictive models to give managers of northern mixed-grass prairie ecosystems an idea of what to expect with regard to animal populations and vegetation communities following prescribed fires.

### Diverse refuge histories

The NWRs used in the studies possess varying management histories and topography, but share many attributes and management issues with most Refuges and Waterfowl Production Areas managed by the U.S. Fish and Wildlife Service in the northern Great Plains.



The study took place between 1998 and 2003 at four NWRs in central and northwestern North Dakota.

The Lostwood, Des Lacs, J. Clark Salyer and the Upper Souris River Refuges have all been designated as “Globally Important Bird Areas” by the American Bird Conservancy, meaning that they contain critical habitat that supports significant populations of endangered or threatened bird species. Their landscapes provide a blend of natural lakes, managed wetlands, rolling mixed-grass prairies, and sheltered river valleys that provide havens for millions of migrating and nesting waterfowl, marsh birds and grassland songbirds. The combined habitats of these Refuges serve as one of the most prolific duck breeding areas in North America.

Until the 1980s, most land in the study sites had been managed for many decades by rest and occasional light grazing—but no fire. Lack of fire allowed expansion of native trees and shrubs into grasslands from adjacent

woodlands and wetlands. Non-native grasses introduced during the early 1900s combined with the influx of trees and shrubs to fundamentally alter the composition and structure of prairie vegetation.

The Lostwood NWR has the longest, most progressive history of prescribed fire use of all the study sites because of a restoration program initiated in the late 1970s by manager Karen Smith. It expanded to Des Lacs NWR in the 1980s, and took hold system-wide in the northern prairies during the 1990s. However the Upper Souris NWR, which is centered among the other study sites, had not burned for over 70 years. These varying management histories provided an ideal laboratory for studying how vegetation structure, bird populations and fire in northern mixed-grass prairie are interrelated.

### Minimize the trees please

Grassland songbirds evolved with specific needs that restrict where and how they can obtain food and build nests. Most of them can only nest in certain types of grass and will not tolerate trees in the landscape. In addition, they aren't physically adapted to move around in dense plant litter when they forage for food. Depending on the species, they need varying degrees of open ground amidst the grass plants as they hunt for bugs and caterpillars.



A Baird's sparrow perched in the grasses of Lostwood NWR. The breeding range of the Baird's sparrow is restricted to northern mixed-grass prairie. Despite prairie remnants set aside for conservation in the eastern portion of their range, the species has become rare. Fire has been excluded from these tracts for decades. Photo by Bietell Photography.

The Baird's sparrow is one of the least flexible grassland songbirds, and is now a species of concern because it only nests in what remains of northern mixed-grass prairie. Murphy emphasizes the importance of paying close attention to such endemic species (species that are completely dependent on habitat features specific to their native ecosystem and not found anywhere else). He points out that if something happens to these last islands of suitable habitat, they have nowhere else to go. "They're really fussy about how tall and sparse the vegetation is. They have to have finely stemmed grasses to nest in. So the heavy, thick stems and leaf blades of invasive, non-natives like smooth brome are a problem for them. Their ideal breeding habitat is created when the fine grasses they require burn every 4 to 5 years."

Trees and shrubs compound the problems for this prairie bird. Tall woody plants around a potential nest site will render an otherwise suitable location unacceptable. If shrubs cover more than 15% of a given nesting territory, Baird's sparrows will leave the area. This is true to some degree for many—but not all grassland species, Murphy says. "If more than 25% of the landscape is in woody cover, 90% of the grassland songbirds will leave. If there's some big, tall, vertical thing even a quarter mile away they won't tolerate it—they won't stay." In this study, nesting success of the common clay-colored sparrow decreased as the number of woody patches within 100 meters increased. In contrast, nest success for Savannah sparrows exhibited no clear relationship to amounts of woody cover in the area.

### Fire hatches the perfect habitat

Results of the project indicate that most species of breeding grassland birds are generally well adapted to fire that recurs every 4 to 6 years. Population levels and nest density declined in the first growing season after fire, but quickly returned to pre-burn levels. Success of nests of mallard and gadwall ducks were at their peak in the first post-fire season. Fire had almost no detectable impact on nest success for any of the grassland bird species. This was somewhat surprising. The researchers expected that the short-term loss of plant litter required for nesting might thwart the birds' reproduction efforts. But the birds appeared to do fine by nesting in vegetation patches that the fire skipped over. These 'skips' proved to be more than adequate nesting locations for most songbirds and ducks.

### Cowbirds converge

The exception was nest success of the Savannah sparrow, which was reduced in the first post-burn growing season not because of the direct effects of fire, but because of increased parasitism by brown-headed cowbirds. Brown-headed cowbirds evolved in the Great Plains right along with grassland songbirds and don't build nests of their own. They rely instead on the nests and parenting efforts of other species to propagate their species. This reduces successful production of young by the host species because baby cowbirds out-compete host nestlings. The success of songbird nests with cowbird chicks can be much lower than that of un-parasitized nests of the same species in the same population. Murphy, Grant and Madden thought that perhaps the Savannah sparrow nests became more vulnerable after fire because of the loss of concealing vegetation. They also considered the possibility that the local cowbirds had simply shifted their target, which they're known to do if a species they rely on for nests is less abundant in a given year. "There may be a few possible explanations," explains Murphy, "but the impact appears to be short lived."

The research also revealed fire-associated changes in the relative abundance of another known nest predator: the deer mouse. It was recently discovered that deer mice are significant predators of ground nesting sparrows. They can be carnivorous, helping themselves to small bird eggs and



Two Savannah sparrow nestlings (orange-colored skin) share tight quarters with two, much larger brown-headed cowbird nestlings (white down and pink skin) at J. Clark Salyer NWR. The size disparity puts the sparrows at a disadvantage when competing for food delivered by parents. Photo by T. Grant.

newly hatched nestlings. In this study, deer mice were five to six times more abundant in the first post-fire season when there was very little plant litter and vegetation. But despite their exploding population, predation by deer mice on nestlings was negligible.

### Prescribed fire

In a vegetation portion of the study, researchers assessed pre- and post-fire plant distribution patterns on over 10,000 acres of prairie on the Des Lacs and J. Clark Salyer NWRs. Mixed-grass prairie on both had been left largely undisturbed during the 1930s through 1980s. They found that most areas were moderately to severely invaded by introduced Kentucky bluegrass and smooth brome, and that native grasses and wildflowers had become rare. Conversely, when they performed the same analysis on privately owned prairie that had been grazed every year for several decades, they found that native plants were more prevalent, although Kentucky bluegrass was still widespread. These findings highlight the shortfalls of managing disturbance-dependent grasslands as static systems for long periods of time. Management primarily by rest appears to give invasive species the upper hand.

As expected, vegetation structure was significantly changed during the first, second and third growing seasons after fire. Composition was generally unchanged. But short term (less than 10 years) fire effects on native and introduced grasses in the Des Lacs NWR were surprising and a little disheartening for the researchers. Smooth brome decreased only a small amount or was unaffected by fire. Native herbaceous

*“Fire didn’t appear to help under these conditions.” Murphy says. “These areas are so overrun by smooth brome that adding fire to the system didn’t help like it did up in Lostwood—where the soils are thinner and drier and the conditions are harsher for introduced plants.”*

### Management Implications

- Prescribed burning to reduce accumulated litter and woody plants appears to be warranted for improving the diversity and productivity of grassland birds, as well as addressing other prairie restoration objectives.
- Frequencies of native herbaceous flora do not appear to increase with prescribed burning in loamy soils already dominated by smooth brome and Kentucky bluegrass, at least in the short term.
- New models provide information about post-fire population responses of breeding grassland birds in addition to potential post-fire vegetation structure and composition.
- A database of roughly 5,000 nests of 35 less common grassland bird species provides new information for managers about breeding biology.

plants didn’t increase at all after fire in areas where these introduced grasses had already taken over, at least in the short term.

“Fire didn’t appear to help under these conditions.” Murphy says. “These areas are so overrun by smooth brome that adding fire to the system didn’t help like it did up in Lostwood—where the soils are thinner and drier and the conditions are harsher for introduced plants.”

He emphasizes the importance of avoiding the assumption that prescribed fire can do it all, or make up for a century of human impacts. “We tend to think of prescribed fire as a silver bullet, but in some cases it may not really be a big help with battling introduced plants. We think that in the richer soils in Des Lacs, the brome really has what it needs to be so competitive. Fire may even be increasing its ability to take over. In many areas, there just aren’t enough native plants left to out-compete it.”

### Expanding inquiry

Funding from the Joint Fire Science Program allowed the researchers to address the justification for prescribed fire, and to study several additional high-priority fire effects concerns. Managers can now identify more clearly the benefits and limitations of prescribed burns with regard to the specific missions, goals and budgets of their respective Refuges. But Murphy cautions that extensive, long-term restoration efforts are expensive and aren’t practical to implement on every conservation tract of grassland in the northern Great Plains region. Now that he and his colleagues know so much more about bird responses to fire and grazing, they plan to focus more on vegetation; specifically the roles of grazing and fire in the management of introduced species and restoration of native plants. Their work will continue to inform and shape efforts to conserve what remains of northern mixed-grass prairie—and restore as much life as possible to this resilient and iconic landscape.

## Further Information: Publications and Web Resources

### Project Overview

[http://www.fws.gov/jclarksalyer/Joint%20Fire%20Science%20Report/Main\\_Page.htm](http://www.fws.gov/jclarksalyer/Joint%20Fire%20Science%20Report/Main_Page.htm)

### J. Clark Salyer / DesLacs Wildlife Refuge Complex

<http://www.fws.gov/jclarksalyer/deslacs/deslacs.htm>

### American Bird Conservancy Globally Important Bird Areas

<http://www.abcbirds.org/abcprograms/domestic/sitebased/iba/index.html>

## Scientist Profile

Robert Murphy currently is an Assistant Professor of Biology at the University of Nebraska in Kearney. His research interests include the breeding ecology of birds of prey, restoration ecology of native prairie-wetland communities, and the relationships between population dynamics of grassland birds and management of their habitats.



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<http://www.fws.gov/mountain-prairie/ND.html>

USGS Northern Prairie Wildlife Research Center

<http://www.npwrc.usgs.gov/>

University of North Dakota

University of Missouri

Federal Youth Conservation Corps

*Results presented in JFSP Final Reports may not have been peer-reviewed and should be interpreted as tentative until published in a peer-reviewed source.*

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## ***Prescribed Fire for Fuel Reduction in Northern Mixed-Grass Prairie: Influence on Habitat and Populations of Indigenous Wildlife and Future Forest Flammability***

**Written By: Kim Hanson**

### **Purpose of this opinion piece**

*Manager's Viewpoint* is an opinion piece written by a fire or land manager based on information in a JFSP final report and other supporting documents. This is our way of helping managers interpret science findings. If readers have differing viewpoints, we encourage further dialogue through additional opinions. Please contact Tim Swedberg to submit input ([timothy\\_swedberg@nifc.blm.gov](mailto:timothy_swedberg@nifc.blm.gov)). Our intent is to start conversations about what works and what doesn't.

### **Problem**

Bob Murphy and colleagues Todd Grant and Elizabeth Madden documented short- and long-term effects of fire on migratory birds with emphasis on grassland songbirds. After a fire event, they determined that vegetation, soil cover, and animals generally returned to pre-burn conditions within 10 years. However, increases in tall woody vegetation in response to reduced fire frequency over the past 100 years might have facilitated reductions of some bird populations.

### **Application for Land Managers: Prescribed Fire in Mixed-Grass Prairie**

Most native prairie in the Dakotas is classified as "northern mixed-grass" prairie. Prescribed fire has been used as a management tool in this prairie ecosystem for more than 25 years. Every year, approximately 25,000 acres of grassland are burned on the national wildlife refuges in North Dakota and eastern Montana. Anecdotal evidence suggests that these treatments have a positive ecological benefit, however the vast majority of research used to analyze these

treatments has been completed in other prairie types. Thus, specific research in the northern mixed-grass prairie is needed to better understand the relationship of fire and other resources.

Wildlife managers knew that native prairie evolved with periodic disturbance by grazing herds of large ungulates and natural or anthropogenic fire. They also knew that excluding grazing and fire from the prairie has led to invasion of non-native grasses and woody trees and shrubs. In addition, most managers were aware that populations of grassland nesting birds were declining. What managers did not know was the effectiveness of prescribed fire in

*“What managers did not know was the effectiveness of prescribed fire in reducing invasive grasses and woody vegetation and—more importantly—what effects fire has on grassland bird populations.”*

reducing invasive grasses and woody vegetation and—more importantly—what effects fire has on grassland bird populations.

### **Researchers, Biologists, and Managers Working Together**

In the final JFSP report, Murphy states, “Our chief goals were to document effects of prescribed burning of northern mixed-grass prairie on the abundance, productivity, and nest site selection of migratory birds, especially grassland songbirds; measure influences of major sources of woody fuels and habitat edges (e.g., woodland, cropland, wetland) on occurrences and productivity of common bird species; and assess relationships between fire history and vegetation composition and structure on several spatial and temporal scales.”

This is exactly the kind of information managers need to effectively manage grassland habitats. Murphy, Grant, and Madden have gained valuable insight through their close working relationships with national wildlife refuge managers. This type of targeted research is essential for adaptive management and what the U.S. Fish and Wildlife Service has termed Strategic Habitat Conservation (SHC). The concept of SHC is an ongoing loop of monitoring and research, biological planning, conservation design, and conservation delivery. As we learn more, we are able to refine our plans and apply the most effective management tools to meet habitat objectives.

### **Relevant Information**

Murphy, Grant, and Madden’s work contains numerous insights for mid-grass prairie management. From my perspective as a manager of national wildlife refuges and Waterfowl Production Areas, the most relevant are:

1. Bird abundance and nest density return to pre-burn levels after the first breeding season and many birds still nest in unburned patches. After the fire, the loss of habitat during the first breeding season is offset by the benefits gained in the long term. Because crews often spend considerable time and effort attempting to burn areas that did not burn after the first ignition, managers should ensure that burn crews are made aware of the benefits of unburned areas.
2. Prescribed fire and the resulting changes in vegetative structure have little impact on nest survival among grassland bird species, even during the first breeding season after burning. Even though deer mice (*Peromyscus maniculatus*) increased 5-6 times over pre-burn densities, they did not significantly increase nest predation. Only Savannah sparrow (*Passerculus sandwichensis*) suffered reduced nest survival during the first post-burn breeding season—the result of increased nest parasitism by brown-headed cowbirds (*Molothrus ater*).  
*“Because significant changes in vegetative composition may not be evident for many decades, good monitoring and accurate records are invaluable.”*
3. Managers should not expect to detect significant changes in plant species after a few years of burning (<10 years), especially in grasslands dominated by Kentucky bluegrass (*Poa pratensis*) and smooth brome (*Bromus inermis*). Native grassland management is a long-term endeavor. Because significant changes in vegetative composition may not be evident for many decades, good monitoring and accurate records are invaluable. Ten, 20, and 30 years

from now, managers will rely on our current monitoring and records to determine the effectiveness of the management tools used in the mixed-grass prairie.

### **Manager Profile**

Kim Hanson is Manager of the U.S. Fish and Wildlife Service (FWS) Arrowwood National Wildlife Refuge Complex. The complex includes Arrowwood and Chase Lake National Wildlife Refuges and Arrowwood, Chase Lake, and Valley City Wetland Management Districts. He supervises the staff responsible for managing 84,355 acres on National Wildlife Refuges and Waterfowl Production Areas spread over nine counties in eastern North Dakota. Prescribed fire is an integral part of habitat management on his complex. After 31 years with the FWS, he still enjoys carrying a drip-torch at least a couple times a year.



*The information for this Manager's Viewpoint is based on JFSP Project 01-3-2-09, Prescribed Fire for Fuel Reduction in Northern Mixed-Grass Prairie: Influence on Habitat and Populations of Indigenous Wildlife and Future Forest Flammability; Principal Investigators: Robert K. Murphy, Todd A. Grant, and Elizabeth M. Madden.*