America's Grasslands: Status, Threats, and Opportunities

The First Biennial Conference on the Conservation of America's Grasslands

August 15-17, 2011
Sioux Falls, SD

Conference Proceedings

America's Grasslands: Status, Threats, and Opportunities

Proceedings of the First Biennial Conference on the Conservation of America's Grasslands

August 15-17, 2011
Sioux Falls, SD

Edited by
Aviva Glaser, National Wildlife Federation

Published
June 2012 by National Wildlife Federation and South Dakota State University

Cover image: Windblown arms of Indian grass and big bluestem, Spring Creek Prairie, Nebraska.
Credit: ©Michael Forsberg, www.michaelforsberg.com

Suggested Citation
Glaser, A., ed. 2012. *America's Grasslands Conference: Status, Threats, and Opportunities. Proceedings of the 1st Biennial Conference on the Conservation of America's Grasslands.* August 15-17, 2011, Sioux Falls, SD. Washington, DC and Brookings, SD: National Wildlife Federation and South Dakota State University.

Table of Contents

Credit: Whitney Tawney, Ducks Unlimited.

Credit: Aviva Glaser, NWF.

Introduction to the Proceedings

Credit: Aviva Glaser, NWF.

It was just over a year ago that National Wildlife Federation, South Dakota State University's Department of Natural Resource Management, and the North Central Sun Grant Center started talking about putting on a conference that would address the growing concerns surrounding the preservation of America's grasslands – one of the most threatened ecosystems in the world. It is estimated that tallgrass prairies and savannas of the mid-western states have declined by as much as 99% as a result of habitat fragmentation, conversion to cropland, and undesirable habitat changes due to fire exclusion, improper grazing management, and use and spread of invasive and non-native plants, among other factors. The ecological and economic importance of grasslands lies not only in the immense area they cover, but also in the diversity of benefits they produce –from nutrient cycling, water retention, aquifer recharge and storage of substantial amounts of atmospheric carbon to improving water infiltration and the quality of runoff water. In the north-central part of the U.S., the prairie potholes contain wetland-grassland complexes that are critical for waterfowl recruitment, producing 50–80% of the continent's duck populations (Cowardin et al. 1983, Batt et al. 1989, Reynolds 2005), and providing breeding habitat for more than half of the grassland bird species breeding in North America (Knopf 1996). As a result of human impact, the biotic diversity of North American grasslands is the most highly impacted of any of the continent's terrestrial ecosystems (Conner et al. 2002).

By March 2011, the National Wildlife Federation and South Dakota State University began planning for the first ever "America's Grasslands: Status, Threats and Opportunities," to be held in Sioux Falls, SD, from August 15-17, 2011. The goal of the conference was to bring together biologists, policy experts, ranchers, federal and state agency staff, representatives of elected officials, and conservationists for two days to discuss the latest information on the status, threats and opportunities related to North American grasslands in order to raise the national profile of this endangered ecosystem and inform those interested in developing a roadmap for its conservation. A series of symposia were developed on selected topics, including grazing and grasslands, grassland restoration and management, energy development, climate change and grasslands, and federal policy. The event was immediately followed by a "Grasslands Policy Summit" on August 18, 2011, sponsored by the National Wildlife Federation, Ducks Unlimited, The Nature Conservancy, and World Wildlife Fund. The goal of the policy summit was to brainstorm strategies to elevate national interest in and promote conservation of North American grasslands.

At the time we started planning this event, none of us knew what an incredible success it was going to be. The conference was attended by ~250 people comprised of academics (24%), federal (25%) and state (12%) agencies, non-profit organizations (30%), and private consultants, landowners, and vendors (9%). Furthermore, we had participants from coast to coast (New York to Oregon and Texas to North Dakota), and four countries (USA, Canada, Mexico, and South Africa).

A major positive outcome of all of the events was the pulling together of the conservation community and the ranching community, including the South Dakota Cattlemen's Association, to discuss common interests in keeping grasslands in grazing. The policy summit resulted in a trio of working groups focused on grasslands policy, raising the national profile of grasslands and engaging ranchers and other producers on grasslands issues. These groups have provided collaborative input on issues such as the national Farm Bill policy, and several participants at the conference have even flown to Washington D.C. to contribute to policy discussions and advocate for grassland conservation in recent months. None of this would have occurred without the conference as an avenue to bring people together and dedicated individuals willing to voice their concerns about the status of our national grasslands.

America's Grasslands Conference participants take a tour of EcoSun Prairie Farms in eastern South Dakota. Credit: Aviva Glaser, NWF.

We are happy to now disseminate the proceedings from this landmark event. The two day conference included 62 speakers and 19 poster presentations. Included in these proceedings are short or extended (3-4 page) abstracts provided by each of the presenters and/or plenary speakers that voluntarily contributed to this effort. We have organized the abstracts into the symposia categories in which they were presented: 1) Status of North American grasslands, 2) Grassland management practices, 3) Climate change and grasslands, 4) Grassland management and bird populations, 5) Energy development and grasslands, 6) The role of federal policy in grassland conversion, 7) The role of federal policy in grassland conservation, 8) Grassland management and conservation, and 9) Poster presentations.

The co-chairs of the "America's Grasslands Conference: Status, Threats, and Opportunities" would like to thank our organizing committee as well as our sponsors. We would also like to thank all the presenters and registrants for contributing to this wonderful event as well as the Sioux Falls Convention Center for providing such a welcoming atmosphere and wonderful food! Based on the success of this conference and the interest of the participants, we would like to make it a biennial event, and will begin finding an institution to co-host a second "America's Grasslands Conference" in 2013. We hope to see you all there!!!

Sincerely,

Julie M. Sibbing
National Wildlife Federation
Event Co-chair

Susan Rupp
South Dakota State University
Event Co-Chair

Organizing Committee

Susan Rupp *(Co-Chair),* South Dakota State University

Julie Sibbing *(Co-Chair),* National Wildlife Federation

James Doolittle, North Central Sun Grant

Jim Faulstich, South Dakota Grasslands Coalition

Aviva Glaser, National Wildlife Federation

Chris Hesla, South Dakota Wildlife Federation

Doug Johnson, U.S. Geological Survey's Northern Prairie Wildlife Research Center

Scott McLeod, Ducks Unlimited

Alexander Smart, South Dakota State University

Ryan Stockwell, National Wildlife Federation

Genevieve Thompson, National Audubon Society in North Dakota

Ryan Welch, University of Northern Iowa's Tallgrass Prairie Center

Sponsors

Co-hosting Institutions:

National Wildlife Federation

South Dakota State University

North Central SunGrant Center

Diamond Sponsors:

POET

The Nature Conservancy

Gold Sponsors:

South Dakota Grassland Coalition

World Wildlife Fund

Truax Company

Silver Sponsors:

South Dakota Wildlife Federation

Millborn Seeds

Julie Sibbing, Lynn Tjeerdsma, and Josh Tonsager speak on the "Overview of Federal Policy and Grasslands" panel. Credit: Aviva Glaser, NWF.

Keynote and Plenary Speakers

Keynote Address:

Bob Budd, Wyoming Wildlife and Natural Resource Trust

Plenary Speakers:

Cows for Conservation

Kurt Forman, U.S. Fish and Wildlife Service

Wildlife and Energy Development: From Science to Solutions

Dr. Kevin Doherty, Prairie Pothole Joint Venture

Economics of Grassland Conversion

Dr. David Archer, USDA Agricultural Research Service

Opportunities for Grassland Conservation

Jim Faulstich, South Dakota Grasslands Coalition

Overview of Federal Policy and Grasslands

Julie Sibbing, National Wildlife Federation

Lynn Tjeerdsma, Office of Sen. Thune

Josh Tonsager, Office of Sen. Johnson

Credit: Aviva Glaser, NWF.

"Vast expanses of prairies, savannas, and steppes once dominated much of the current arable land in the US. These were grasslands, the largest vegetation formation in North America. During settlement and subsequent development, these grasslands represented a substantial ecological resource that sustained a large portion of the US economy. Through time, the ecological and economic functions of these lands have changed… Much of the historical grassland area has been converted to other land use – perhaps irreversibly. Much of what remains is degraded to the point that it is no longer capable of supporting the same level or variety of ecological and economic services. However, many natural grassland systems are resilient and they may realize much of their ecological and economic potential subsequent to recovery and restoration efforts."

- Conner, R., A. Seidl, L. Van Tassell, and N. Wilkins. 2001. United States Grasslands and Related Resources: An economic and biological trends assessment. http://www.landinfo.tamu.edu

1

Status of Grasslands and Dependent Wildlife

The State of the Prairie Potholes

Presenter: Kevin Doherty, Prairie Pothole Joint Venture USFWS (Kevin_Doherty@fws.gov)

Other authors: Adam Ryba, Casey Stemler, Neal Niemuth, Kurt Forman, Scott McLeod - All USFWS

Are conservation efforts in the prairies gaining ground through permanent protection or are they just slowing the retreat? We assembled all scientific references and summarized additional information from U.S. and state government databases relevant to the Prairie Pothole Joint Venture (PPJV). We obtained and synthesized information on status (total amounts) and trends (rate of loss or conservation gains) for grasslands, wetlands, and all state and federal conservation programs. We compare and contrast the empirical rates of conservation gains versus wetland and grassland losses to provide context to the state of the Prairie Pothole ecosystem. All scientific papers and all government data sets indicate conversion of grasslands and drainage of wetlands will continue. In all states, more grasslands are lost per year than can be protected by the collective partnership. If current grassland losses are annualized, all grass cover could be lost in as little as 75 years. In North and South Dakota, yearly wetlands protection exceeds drainage rates, but losses are still occurring despite the Swampbuster provision in the Farm Bill. Impacts of tile drainage are unknown. In the final section we present data on trends in drivers of land conversion and land use to assess how they might affect future land use. We found that price of cropland has increased 158 – 249% during the last decade which will dramatically reduce ability to deliver conservation. Further, trends in agriculture are favoring more intensive crop types (i.e. corn and soy bean). In states like Iowa and South Dakota, corn based ethanol is diverting 39% and 30% of all cropland within the PPJV for energy purposes, which increases pressure to convert remaining grasslands. Data on wind development indicate siting to avoid areas with low human footprint is mixed. We think this report provides context to inform conservation decisions and provide direction for conservation efforts in the prairies.

Documenting and Protecting Minnesota's Remaining Native Prairies

Presenters: Fred S. Harris, Minnesota County Biological Survey (fred.harris@state.mn.us) and Jason Garms, Minnesota Scientific and Natural Areas Program (jason.garms@state.mn.us)

Tallgrass prairie once covered approximately 18 million acres in western and southern Minnesota (Marschner 1974). The soil developed by prairie plants over thousands of years is now the basis of Minnesota's rich agricultural economy and, over the last 150 years, has been largely converted to row crop agriculture.

Over the past twenty-five years, the Minnesota County Biological Survey (MCBS), a program of the Minnesota Department of Natural Resources, systematically mapped, evaluated, and sampled Minnesota's remaining native prairie and associated rare plant and animal species. Approximately 231,000 acres (or 1.3%) remain of the original, unplowed, native prairie in Minnesota (Figure 1), and many of the prairie obligate species dependent on them are Species of Greatest Conservation Need. More than 70% of Minnesota's remaining prairie exists in one of twenty-nine identifiable large prairie landscapes. The largest landscape is the 297,000 acre Aspen Parklands of far northwestern Minnesota, which contains approximately 45,000 acres of native prairie embedded in complex mosaics with wetland and wooded communities. The state's largest remaining tracts of mesic and wet prairie persist in northwestern Minnesota along gravelly former beaches of glacial Lake Agassiz. The largest landscape in southern Minnesota is the 106,000 acre Lac Qui Parle Prairie, containing 16,000 acres of native prairie mostly on boulder-strewn glacial river terraces in the Minnesota River valley. Over 90% of the prairie remaining elsewhere in southern Minnesota are dry prairie types on steep slopes and sandy or gravelly soils. MCBS ecologists also compiled over 1,200 vegetation plots (relevés) in the prairie region, which formed the basis for a new classification of Minnesota's native prairie communities and descriptions in plant community field guides. Additional information and detailed maps are on the Minnesota DNR website at http://www.dnr.state.mn.us/eco/mcbs/index.html.

About 47% (110,000 acres) of Minnesota's remaining prairie is currently protected under conservation ownership and 5% (11,000 acres) with conservation easements. The near elimination of native prairie in Minnesota has inspired many efforts to protect all remaining parcels. Strategies being deployed include acquisition of public Wildlife Management Areas and Scientific & Natural Areas and innovative ways to work with private lands owners, such as the Native Prairie Bank Program and Working Lands Initiative. The Native Prairie Bank program has enrolled 102 perpetual easements totalling 8,132 acres, including several of the state's highest quality prairies in private ownership. Minnesota's unique Prairie Tax Exemption program has exempted 529 tracts from property tax, totalling 20,216 acres of native prairie.

In 2008, Minnesota citizens passed a constitutional amendment to increase state sales tax and create the Outdoor Heritage Fund, allocating an additional 70 to 100 million dollars per year to "restore, protect, and enhance prairies, forests, wetlands, and habitat for fish, game and wildlife." Faced with this new funding opportunity and continuing losses of prairie habitats, representatives from eight conservation groups completed a comprehensive, twenty-five year plan to accelerate the conservation of native prairie, grassland and wetlands in western Minnesota (Minnesota Prairie Plan Working Group 2011). The plan identifies strategies and goals for building more viable prairie landscapes in thirty-nine core areas, corridors connecting core areas, and additional blocks in Minnesota's prairie region. To achieve this, the plan recommends acquisition of over 800,000 acres and restoration of 516,000 acres over the next twenty-five years, as well as annual management activities on 477,000 acres. The plan can be obtained from the Minnesota DNR website at http://files.dnr.state.mn.us/eco/mcbs/mn_prairie_conservation_plan.pdf.

References

Marschner, F.J. (1974) The original vegetation of Minnesota, compiled from U.S. General Land Office Survey notes by Francis J. Marschner [map]. 1:500,000. Redrafted from the original by P.J. Burwell and S.J. Haas under the direction of M.L. Heinselman. St. Paul: North Central Forest Experiment Station, United States Department of Agriculture.

Minnesota Prairie Plan Working Group. (2011) Minnesota Prairie Conservation Plan 2010. Minnesota Prairie Plan Working Group, Minneapolis, MN. 55p.

Assessing the change in tallgrass prairie vegetation within the Cherokee Prairie from 1898 to 2008

Presenter: Melissa Hinten, University of Oklahoma (mtalley@ou.edu)

Co-author: Bruce Hoagland, Oklahoma Biological Survey, University of Oklahoma

The historical native vegetation of upland areas within the Cherokee Prairie, located in northeastern Oklahoma, is

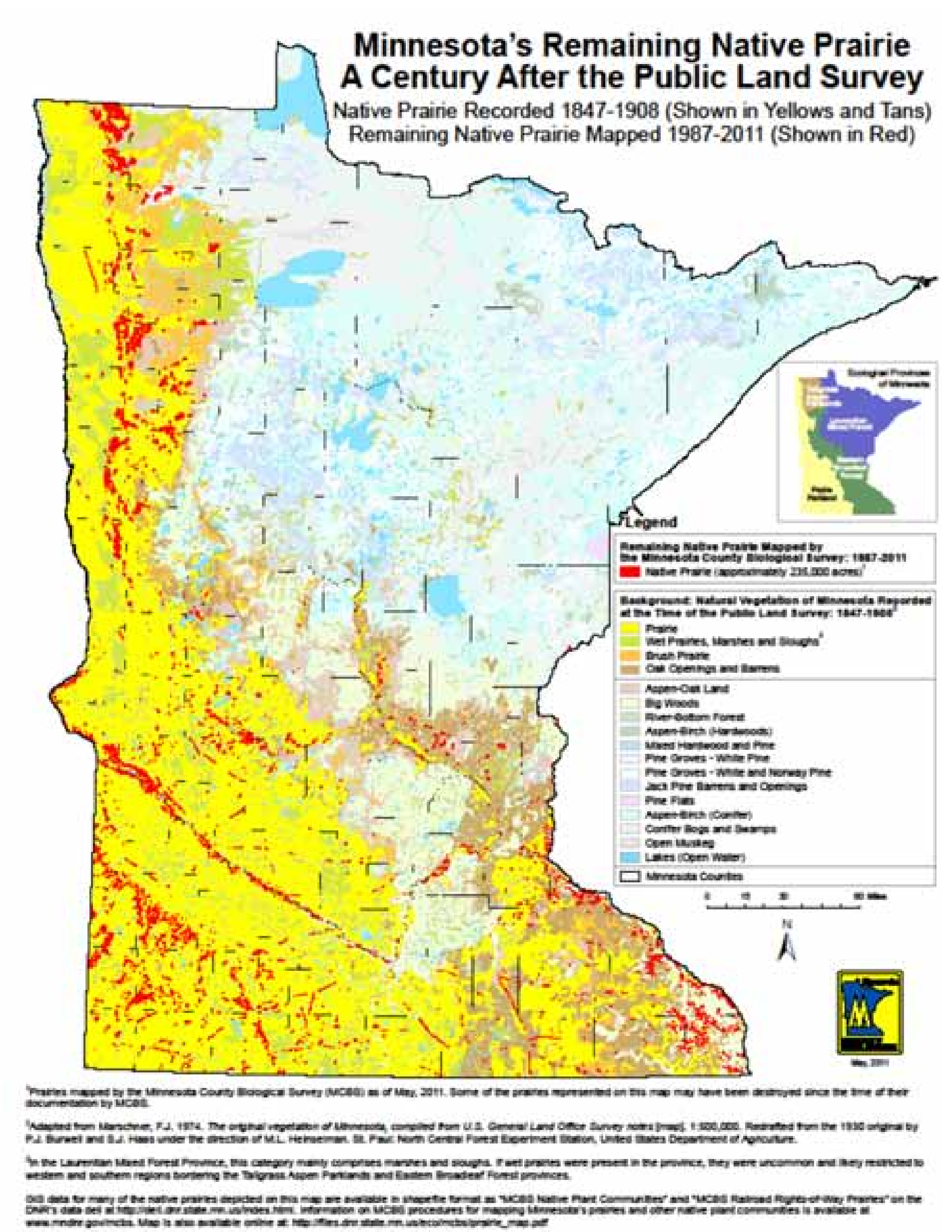


Figure 1.

tallgrass prairie vegetation. The objective of this study is to quantify the loss and fragmentation of tallgrass prairie vegetation within the Cherokee Prairie. To do this we created spatial layers within a geographic information system. A historic tallgrass prairie vegetation layer was created from Public Land Survey (PLS) Plats. The PLS plats for the Cherokee Prairie are from the survey of Indian Territory carried out just prior to allotment. The 2008 layer was created from a comparative analysis of County Mosaic images published by the National Agriculture Imagery Program, the Oklahoma GAP Analysis (OKGap) land cover layer, and The Nature Conservancy's Untilled Landscapes layer. Using Patch Analyst we found that the total landscape area of tallgrass prairie vegetation decreased by 65%, the mean patch size decreased by 85%, while the number of patches quadrupled from 1898 to 2008. Remnant tallgrass prairie within the Cherokee Prairie is found as a few large patches, maintained by cattle grazing operations, and multiple smaller patches maintained as native hay meadows. Grazed patches were found in areas with greater topographic relief than the surrounding prairie, while hay meadows were found scattered throughout the study area, and made up the majority of remnant patches. Native hay meadows are relictual landscapes maintained for annual hay production. Native hay meadows are important reservoirs of biodiversity. Within the Cherokee Prairie native hay meadows are potential habitats for rare grassland species, such as Oklahoma grass pink *(Calopogon oklahomensis),* western fringed prairie orchid *(Platanthera praeclara),* and the endemic Oklahoma beardtongue *(Penstemon oklahomensis).* Producing native prairie hay is not highly profitable. Threats to protecting native hay meadows include conversion to more profitable land uses, which include urban expansion of the Tulsa metropolitan area, and introduction of non-native forage crops, such as tall fescue *(Schedonorus phoenix).*

What is the future of tallgrass prairie patches in Oklahoma?

Presenter: Priscilla H. C. Crawford, Oklahoma Natural Areas Registry, University of Oklahoma (prill@ou.edu)

Other authors: Melissa Hinten & Bruce Hoagland, University of Oklahoma

The tallgrass prairie province of Oklahoma has lost many acres of native vegetation since European settlement and what is left is significantly fragmented. For one region in northeastern Oklahoma there has been an estimated 65% decrease in prairie acreage since 1898, with the average size of a prairie patch decreasing by 85%. These small prairie remnants make up a fragile network of native biodiversity at the southern extent of the tallgrass prairie ecoregion. Unfortunately, the destruction of tallgrass prairie hasn't stopped. Native grassland patches continue to be converted for such uses as residential areas, plowed cropland, or improved rangeland (with the addition of exotic grasses). We examine the potential future of present day prairie patches through a variety of methods. Using computer models, we correlate the fragmentation pattern to spatial variables, both environmental and social. Environmental variables used in the modelling include soil type, surface geology, precipitation, length of growing season, and current landcover. Social variables will include population density, recent landcover change, and road network. These correlation patterns can help to identify current patches that are most vulnerable to future destruction. We also interview current landowners to better understand the history of their properties, their motivation for maintaining these properties as native grasslands, and their plans for the land in the future. To encourage protection of these prairie remnants, we present the landowners with conservation options ranging from the no-obligation Oklahoma Natural Areas Registry Program to legal agreements such as conservation easements.

Disappearing Prairie-Dependent Lepidoptera across the Remnant Tallgrass Prairies of Iowa, Minnesota, North and South Dakota

Presenter: Dennis Skadsen, Day Conservation District, SD (dennis.skadsen@sd.nacdnet.net)

Other Authors: Robert P. Dana, Minnesota Department of Natural Resources; Ronald Alan Royer, Minot State University; Garry Selby, Ecological and GIS Services.

Several species of prairie-dependent Lepidoptera have disappeared during the last decade on tallgrass prairie remnants monitored in Iowa, Minnesota, North and South Dakota. Prairie-dependent Lepidoptera are described as those species or sub-species that depend solely on native tallgrass prairie vegetation for survival. The decline of two species endemic to the tallgrass prairie have been well documented in recent years; the Dakota skipper *(Hesperia dacotae),* a candidate for listing as a federally threatened species, and the Poweshiek skipperling *(Oarisma poweshiek),* a species that has disappeared at an alarming rate during the last decade. In the past reasons for the decline of these butterflies have been attributed to the continued conversion of native prairie to cropland and the increase in invasive exotic plants that degrade prairie habitat. In recent years, however, populations of prairie-dependent butterflies once considered secure have disappeared on preserves managed to maintain prairie flora and fauna. While prescribed fire has been cited as a reason for declines at some of these sites, prairie-dependent butterflies are disappearing from sites that have never been burned. Clearly, other factors are contributing to the decline of prairie-dependent butterflies and further studies are being proposed to determine these factors.

Status and distribution of wintering grassland birds in the Chihuahuan Desert: Will increasing threats permit their survival?

Presenter: Nancy Drilling, Rocky Mountain Bird Observatory (RMBO) (nancy.drilling@rmbo.org)

Other authors: Matthew Webb, Colorado State University; Greg Levandoski, RMBO; Arvind Panjabi (arvind.panjabi@rmbo.org), RMBO; and Alberto Macias-Duarte, RMBO

Introduction

North American grassland birds are experiencing widespread population declines (Sauer, 2011), likely due to the degradation and loss of habitat over the majority of their range. One of the most important and understudied aspects of the ecology of grassland birds is their winter distribution and abundance. More than 85% of grassland species that breed in North America overwinter in the limited Chihuahuan Desert grasslands of southwestern USA and northern Mexico. These grasslands are increasingly disappearing due to poor management, conversion to agriculture, desertification and shrub encroachment.

Recent agricultural expansion is rapidly decreasing the extent of these grasslands, particularly in northern Mexico. Although not precisely known, rates of grassland disappearance appear to be increasing in an unsustainable manner. Macias-Duarte et al. (2009) noted that a majority (~30,000 ha) of the study site that they had shown to be used preferentially by wintering grassland birds had been converted to agriculture within the last few years of their study. Many grassland species require open areas with short grasses void of shrubs (Vickery et al. 1999). The rapid encroachment of shrubs into the grasslands of northern Mexico poses a serious threat to the overwinter survival of these species.

Most grassland species with declining populations depend on the grasslands of the Chihuahuan Desert during the non-breeding season. Continued loss of grasslands will likely increase rates of population decline and could eventually create a permanent bottleneck, thus limiting conservation efforts and erasing any hope of recovery for North American grassland species. Limited knowledge of distributions, abundances and habitat use of grassland birds creates difficulties for the implementation of conservation programs for the region. This information is urgently needed in order to advance conservation actions while opportunities still exist.

In 2007, Rocky Mountain Bird Observatory, in partnership with Universidad Autónoma de Nuevo León, began the task of inventorying, researching, and monitoring wintering birds in grassland sites in Chihuahuan Desert Grassland Priority Conservation Areas (GPCAs) (CEC & TNC, 2005) throughout northern Mexico, Texas, Arizona and New Mexico. We also initiated an overwinter survival study on Vesper Sparrows (Pooecetes gramineus) within the Janos GPCA, and began a comprehensive analysis, in conjunction with Bismarck State College, of land-use changes within the Valles Centrales GCPA. We wished to provide information based on a random sampling protocol, which could be used for further inference to the region as a whole in order to properly inform conservation efforts and ensure that resources are focused in areas of greatest conservation value.

Methods

Monitoring: During the winters of 2007 - 2011 we conducted 3,268 one-kilometer transect surveys in up to 15 GPCAs throughout the Chihuahuan Desert. Our bird survey methodology followed Buckland et al. (2001) to account for differential detectability of species, modified slightly for this study (Panjabi et al. 2007, Levandoski et al. 2008, and Panjabi et al. 2010). Ocular estimates of vegetation were taken at each site to determine ground cover and characterize habitat structure. In 2008, we intensely surveyed the vegetation cover using a line-transect protocol (Levandoski 2008). We generated density estimates for each GPCA/Year combination using program DISTANCE *(Thomas, et al. 2010).*

Over-winter Survival: During the winters of 2009 and 2010, 102 Vesper Sparrow were caught and tagged with radio transmitters. Technicians tracked and recorded the fate of the birds for up to 51 days to determine over-winter survival rates. This effort was in to investigate the feasibility of expanding to include other priority species in future years.

Remote Sensing Analysis: In partnership with RMBO, students of Dr. Duane Pool in the Advanced GIS Modeling class at Bismarck State College in Bismarck, North Dakota analyzed remote sensing imagery of the Valles Centrales GPCA from 2006 to 2010 and measured grassland loss through expansion of agriculture throughout the GPCA (Pool, unpublished data).

Results and Discussion

Our monitoring surveys have generated data on habitat conditions and abundances of 50 grassland obligate or facultative species in the 15 GPCAs, including 30 priority species of high regional or continental conservation interest. We obtained reasonably precise annual estimates of density for 29 species, including 18 priority species, in at least one GPCA within or across years.

Using this data, spatial-temporal distribution patterns of some species have become apparent. For example, we found Chestnut-collared Longspurs to be concentrated in the northern and western portions of the Chihuahuan Desert, but higher numbers were present in the northeastern portion of the desert in some years. Populations of Sprague's Pipit were generally concentrated in the southern portion of the desert although they were more dispersed in 2011. In 2009, populations of Baird's Sparrow were distributed further east than in other years. Baird's Sparrow was generally most abundant in the western Chihuahuan Desert within the Sierra Madre Occidental foothills of southern Chihuahua and northern Durango. The discovery of this core wintering area is an important and novel piece of information that will aid the conservation of this species. Grasshopper Sparrow populations were generally widespread, but concentrations changed over the years. Most were found in the southern portions of the desert in 2007 and 2010, but were more centrally located in 2009. Our results show that wintering grassland bird densities vary across the Chihuahuan Desert in both time and space. Some species showed clear patterns of consistent high use or avoidance among the GPCAs, for others the picture is less clear. More research is needed to elucidate sporadic species-specific use of some grassland areas.

The variation in densities and distributions year to year throughout the GPCAs is probably a result of climate driven changes in the distribution of resources needed by each species. This shows the ability of birds to track and follow conditions throughout the Chihuahuan Desert and magnifies the need to broaden the spread of conservation efforts to include the whole of the desert. Habitat relationships show that birds prefer grassland conditions that are relatively rare and disappearing at very high rates. In light of the increasing rates of conversion of grasslands to agriculture, well focused conservation efforts need to be put to work in order to save what little winter habitat remains for these migratory species. Our data reveal geographic patterns in species distribution that could be used to delineate management units and help focus conservation efforts to the areas that would result in the highest conservation yield.

Using habitat variables we modeled habitat relationships for 17 species in a Generalized Linear Modeling (GLM) environment, using flock size as a response variable and vegetation characteristic as the predictor variable. GLM analysis of habitat characteristics revealed habitat requirements of several species (Panjabi et al. 2010). Chestnut-collared Longspur and Sprague's Pipit preferred habitat that had very little shrub cover but high percentages of grass cover. More species seemed to be positively affected by the amount of grass cover than any other vegetation characteristic analyzed. Horned Lark was the only species with a negative relationship with grass cover. Shrub cover negatively affected many species that have experienced the steepest population declines over recent years. Many of the GPCAs have seen an increase in shrub coverage due, in part, to poor management.

Overgrazing and mismanagement of grasslands affects species in other ways as well. Results of the survival study with radio-tagged Vesper Sparrows demonstrated that habitat condition is important to the successful overwintering of species (Macias-Duarte & Panjabi, unpublished data). Daily survival of Vesper Sparrows increased dramatically with taller grass heights. Shorter grass reduced survival, presumably by increasing a species' exposure to predators. Overall, we found Vesper Sparrows in northwestern Chihuahua to have an over-winter (5 month) survival rate that was too low to permit long-term viability. It is likely that winter survival could be a limiting factor for this species. Improving grassland conditions is a key strategy for halting decline in populations.

Valley bottoms have traditionally provided the greatest quality and extent of grasslands for wintering grassland birds. These are the same grasslands currently targeted for conversion to agriculture. Remote sensing analysis showed that between 2006 and 2010 conversion of grasslands into agriculture within the Valles Centrales GPCA increased dramatically and that hundreds of thousands of hectares have been lost (Pool, unpublished data). We estimate that in this time, as many as one million grassland birds were displaced, over half of them Chestnut-collared Longspurs, which rely heavily on Valles Centrales for their wintering ground. With over one million acres sold for conversion into agriculture (Enrique Carreón pers. comm.), more loss can be expected over the next few years. Much of this conversion is done illegally and at current rates valley bottom and low slope grasslands within Valles Centrales will be extirpated within two decades.

The loss of grasslands does not only affect migratory species; the Tarabillas Valley, within the Valles Centrales GPCA, was the last stronghold of the native desert-breeding Aplomado Falcon (Falco femoralis). Largely due to conversion to agriculture over the past ten years, 20 known breeding pairs have been reduced to three (Macias-Duarte, pers. comm.).

The drive to convert native grasslands into agriculture is but one threat to desert grasslands. Over the years, incompatible grazing regimes have also degraded the grasslands. This, combined with increasing aridity, has resulted in decreased productivity of these lands and has exacerbated the encroachment of shrubs replacing native grasses. With decreasing profits, ranchers have been forced to sell their land as recent droughts persist. It is imperative that conversion be stopped and management improved in order to halt population declines.

References

Buckland, S. T., et al. (2001) *Introduction to Distance Sampling: Estimating Abundance of Biological Populations.* Oxford University Press. Oxford.

CEC & TNC. (2005) *North American Central grasslands priority conservation areas: technical report and documentation.* (eds. J.W. Karl & J. Hoth), Commission for Environmental Cooperation and The Nature Conservancy. Montreal, Quebec.

Levandoski, G., Panjabi, A., & Sparks, R. (2008). *Wintering Bird Inventory and Monitoring in Priority Conservation Areas in Chihuahuan Desert Grasslands in Mexico: 2008 results.* Rocky Mountain Bird Observatory, Brighton, CO.

Macias-Duarte et al. (2009) Factors influencing habitat use by migratory grassland birds in the state of Chihuahua, Mexico. The Auk **126(4**), 896-905.

Panjabi, A., Levandoski, G., & Sparks, R. (2007) *Wintering Bird Inventory and Monitoring in Priority Conservation Areas in Chihuahuan Desert Grasslands in Mexico 2007 pilot results.* Rocky Mountain Bird Observatory, Brighton, CO.

Panjabi, A., Youngberg, E. & Levandoski, G. (2010) *Wintering Grassland Bird Density in Chihuahuan Desert Grassland Priority Conservation Areas, 2007-2010.* Rocky Mountain Bird Observatory, Brighton, CO.

Sauer, J. R., et al. (2011) *The North American Breeding Bird Survey, Results and Analysis 1966 - 2009.* Version 3.23.2011 USGS Patuxent Wildlife Research Center, Laurel, MD.

Thomas, L., et al. (2010) Distance software: design and analysis of distance sampling surveys for estimating population size. *Journal of Applied Ecology,* **47**, 5-14.

Vickery, P.D., et al. (1999) Conservation of Grassland Birds in the Western Hemisphere. In, Ecology and Conservation of Grassland Birds of the Western Hemisphere by (eds. Vickery and Herkert) *Studies in Avian Biology,* **19**, 2-26.

Protecting the prairie: a historical, current and future look at the protected status of the Northern Great Plains

Presenter: Sarah K. F. Olimb, World Wildlife Fund (sarah.olimb@wwfus.org)

Co-author: Steve Forrest, Environmental Consultant

Of the planet's 14 terrestrial biomes, nine are protected by more than 10%. At the bottom of the list (along with Lake Systems) are Temperate Grasslands, with only an estimated 4.59% in protected status. With so little focus on the Grasslands biome, the available data on protected areas is relatively poor. World Wildlife Fund (WWF) is working to develop a comprehensive database of protected lands in the Northern Great Plains (NGP) ecoregion which spans a portion of five states (Montana, Wyoming, North Dakota, South Dakota, and Nebraska) and two Canadian provinces (Alberta and Saskatchewan).

The WWF database was adapted from the Protected Areas Database of the United States (PAD-US) through the addition and reclassification of protected areas. PAD-US does not generally include military or tribal lands or those secured for less than permanent time frames. WWF is working to evaluate such areas, as well as other private lands that do not meet the protected area criteria, on a case-by-case basis.

Through the database, we have been able to gain perspective on the historical trend of protected status in the NGP. Considering only IUCN categories I – IV, those that

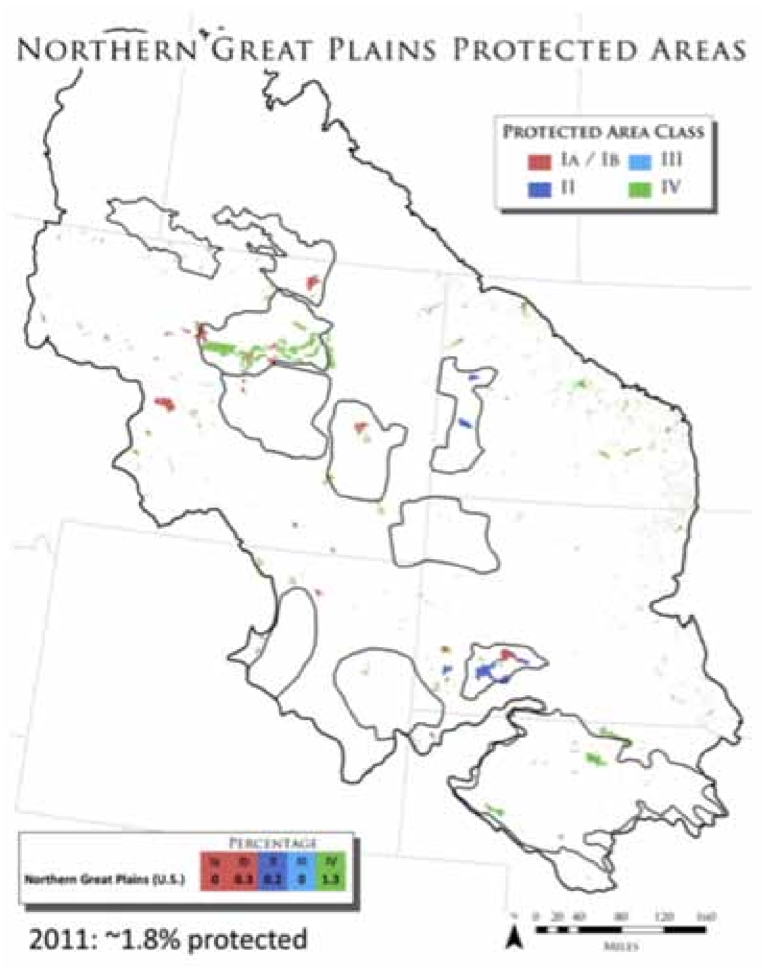


Figure 2. Current status of protected lands in the U.S. portion of the Northern Great Plains Ecoregion identified by IUCN protected area categories I through IV. In 2011, roughly 1.8% of the ecoregion is protected. Please note that this database is a work in progress.

Credit: Aviva Glaser, NWF.

Credit: Aviva Glaser, NWF.

offer more stringent wildlife protection, we looked at the designation of protected areas over the last five decades in the U.S. portion of the NGP. Pre-1950, only roughly 0.74% of the ecoregion was in protected status and this number increased little (~0.01%) through the 1950s and 1960s. In the 1970s, several Wilderness Study Areas were designated, bringing the protected status to roughly 0.84%. Additional designations of public lands (Wilderness, Wilderness Study Areas, and National Wildlife Refuges) in the 1980s increased the protected status to roughly 1.17%. In the 1990s and 2000s, designation of conservation easements and additional public lands added to the total, bringing the conservation status to roughly 1.33% by 2000 and 1.8% by the current year (2011; Figure 2).

The IUCN/WCPA (World Commission on Protected Areas) set a benchmark of 10% protected status for temperature grasslands in order for the ecosystem to reserve its "rightful place" in the system of global protected areas (since temperature grasslands compose roughly 9% of the earth's terrestrial land cover). This benchmark is increasingly important with the escalating threats, in large part from habitat fragmentation, habitat alteration, invasive species, and climate change, facing biodiversity in the ecoregion.

In order to reach 10% protected status and combat the threats to the ecoregion, it is necessary to identify protected areas that: 1) are large enough or frequent enough to preserve genetic viability and thus long-term biodiversity; and that also 2) incorporate not just large acreages, but include the right variation of habitat for conserving species. Protected areas need to be large or frequent enough to preserve migration routes, especially for large herbivores and migratory birds. And, protected areas need to consider future impacts of climate change by offering refugia for species as native habitats are altered.

WWF's vision for the future of the NGP is a healthy and well-managed landscape that conserves all native species, biotic communities, and ecological and evolutionary processes through a combination of approaches which include: 1) Establishing large conservation areas that protect keystone species; 2) Promoting sustainable farming and ranching practices; and 3) Working with local communities to create economic opportunities linked to conservation.

Grassland Management Practices

Salt Cedar. Steven Perkins @ USDA-NRCS PLANTS Database.

Managing saltcedar *(Tamarix spp.)* with fire in northern grasslands

Presenter: Michelle Ohrtman, South Dakota State University (michelle.ohrtman@sdstate.edu)

Other authors: Sharon Clay, David Clay, Eric Mousel, and Alexander (Sandy) Smart, South Dakota State University.

Saltcedar invasion is relatively new in northern regions with many suitable habitats still showing undetectable levels of this non-native plant. Seasonally wet areas that are adjacent to viable seed sources, such as the Prairie Pothole region of the Northern Great Plains, are particularly vulnerable to saltcedar invasion. Controlled burns are being tested to manage non-native grasses in northern grasslands but little is known about the effects of this management tool on saltcedar establishment. Saltcedar establishment in response to fire was investigated in eastern South Dakota soils in replicated greenhouse and laboratory studies. Saltcedar was seeded into soil cores containing intact grassland vegetation from burned and unburned field plots and soil-lined aluminum weighing pans. Vegetation in unburned soil cores was burned 24-hr after seed deposition. The impact of fire temperature and duration on seed viability and seedling survival was determined using a laboratory oven as a fire surrogate. Results suggest that fire may inadvertently promote saltcedar spread by opening the vegetative canopy. Greater seedling establishment occurred if seeds were deposited after fire but before vegetative re-growth. Controlled burning after seed deposition and germination can decrease saltcedar invasion potential if managed properly, although saturated soil conditions near potholes may buffer seeds and seedlings against lethal temperatures. Seeds and young seedlings (up to 5 d old) did not survive when the temperature was high enough (>121oC) and duration was long enough (≥ 5 m). Deposited seeds are more likely to survive elevated temperatures than developing seedlings but because seeds germinate rapidly

"Grasslands play a unique role as they link agriculture and environment and offer tangible solutions ranging from their contribution to mitigation of and adaptation to climate change, to improvement of land and ecosystem health and resilience, biological diversity and water cycles while serving as a basis of agricultural productivity and economic growth."

–Jutzi, S. and S. Pandey. 2009. Grassland carbon sequestration: management, policy and economics. Proceedings of the Workshop on the role of grassland carbon sequestration in the mitigation of climate change. Integrated Crop Management Vol. 11–2010.

upon wetting, fire will more likely encounter seedlings. Land managers need to understand that controlled burns must be done during early seedling development as older saltcedar plants may be more fire-resistant and can also produce new shoots from perenneating root buds. Post-fire monitoring is required to identify and treat seedlings that survive burning or establish after fire.

References

Ohrtman, M. K., S. A. Clay, D. E. Clay, E. M. Mousel, and A. J. Smart. (2011) Preventing saltcedar *(Tamarix spp.)* seedling establishment in the Northern Prairie Pothole Region. *Invasive Plant Sci. Manag.* 4, 427-436.

Ohrtman, M. K., S. A. Clay, D. E. Clay, and A. J. Smart. 2012. Fire as a tool for controlling saltcedar *(Tamarix spp.)* seedlings. *Invasive Plant Sci.* Manag. In Press.

Early Season Clipping, Fire, and Late Spring Nitrogen Application on Improving Native Tallgrass Prairie

Presenter: Alexander J. Smart, South Dakota State University (alexander.smart@sdstate.edu)

Other Authors: Tabitha K. Christner, USDA-NRCS; Eric M. Mousel, Sharon A. Clay, and David E. Clay, South Dakota State University

Defoliation aimed at introduced cool-season grasses, which use similar resources of native grasses, could substantially reduce their competitiveness and improve the quality of the northern tallgrass prairie. We examined the use of early season clipping and fire in conjunction with late spring nitrogen application (to simulate increased atmospheric wet nitrogen deposition) on foliar canopy cover of tallgrass prairie vegetation. This study was conducted from 2009-2010 at two locations in eastern South Dakota. Small plots arranged in a split split-plot treatment design were randomized in four complete blocks on pastures in near Brookings and Volga, SD. The whole plot consisted of annual fire, biennial fire, annual no-fire, and biennial no-fire. The subplot consisted of weekly clip in May or no-clip and the sub subplot consisted of nitrogen applied at 0 kg/ha N or 15 kg/ha in mid-June. All treatments were applied in 2009 and in 2010 only the annual treatments were applied.

Foliar cover of major plant functional groups was estimated in late August 2010. Combinations of annual spring burning and intensive clipping on an annual basis reduced introduced cool-season grasses and promoted warm-season grass species in eastern South Dakota (Figures 3 and 4). When plots were untreated (biennial plots), the foliar cover of introduced cool-season grasses increased and warm-season grasses decreased to pretreatment levels with a slight carryover effect observed in some treatments (Figures 3 and 4). A small amount of nitrogen (15 kg/ha) stimulated introduced cool-season grass cover on untreated plots (28% vs. 15% cover) at the Volga site. Management (fire) with or without supplemental nitrogen did not differ in introduced cool-season grass cover (10% cover). Increases in atmospheric wet deposition of nitrogen could shift unmanaged native prairies toward increased exotic cool-season grasses; however prairies that are frequently burned or perhaps grazed intensively in the spring could offset this effect. Further evaluation is necessary to determine what frequency and treatment combinations will be most effective for continued control or suppression of introduced grass species to allow for restoration and conservation of native tallgrass prairie communities in this region.

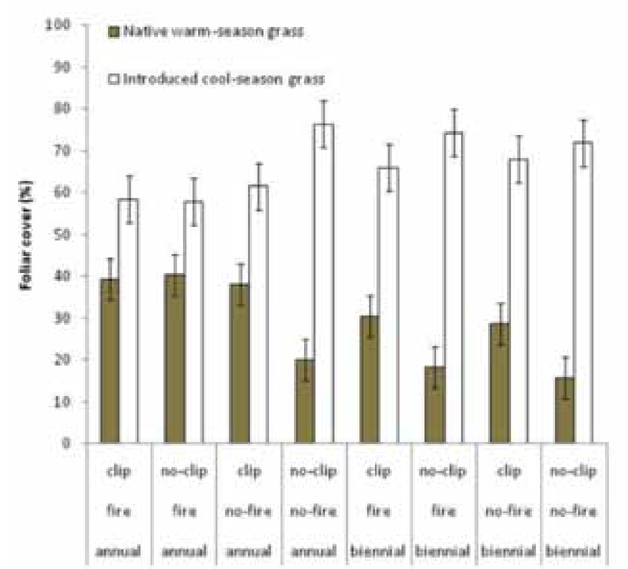


Figure 3. Foliar cover of native warm-season and introduced cool-season grasses in late August 2010 near Brookings, SD.

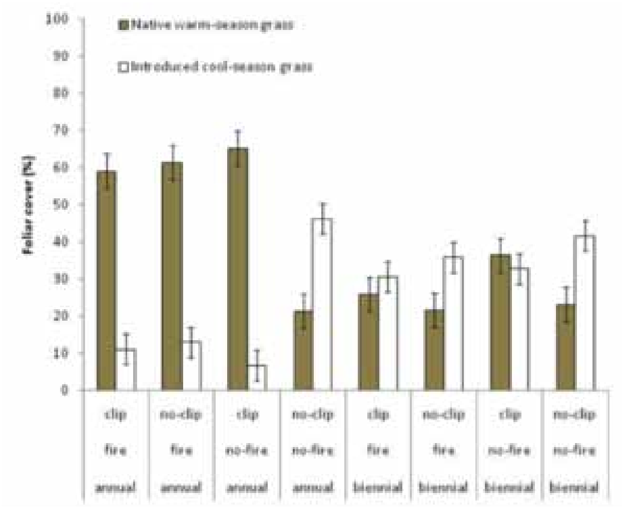


Figure 4. Foliar cover of native warm-season and introduced cool-season grasses in late August 2010 near Volga, SD.

Patch-Burn Grazing Influences on Spring Fire Temperatures and Sericea Lespedeza *(Lespedeza cuneata)* Seed Viability

Presenter: Brenda A. Koerner, Emporia State University (bkoerner@emporia.edu)
Co-author: Nicholas E. Bell, Emporia State University

Introduction

Sericea lespedeza (Lespedeza cuneata), an invasive non-native legume, is currently listed as a noxious weed in Kansas and Colorado, and is treated as a noxious weed in several other states (USDA, 2011). Initially, sericea was introduced into the Midwest as cattle forage, wildlife habitat, and for soil erosion control (Ohlebush et al. 2007). This plant threatens native plant diversity in tallgrass prairie, and aggressively expands into intact, native prairie (Eddy and Moore 1998). The invasive success of this plant results from multiple reproductive strategies, allelopathy, and vigorous growth above- and below ground (Kalburtji and Mosjidis 1993; Dudley and Fick 2003; Woods et al. 2008). Current recommended control practices include herbicide use, fire and grazing management, and mowing to prevent seed production (KSDA, 2011). Herbicides are the most effective control against sericea expansion, but herbicides are costly and are lethal to non-target species.

Fire, a common management practice in tallgrass prairie of the Flint Hills of Kansas, maintains ecosystem integrity, enhances plant productivity and livestock gains, and has been shown to influence the expansion of sericea (Owensby and Smith 1973; Fuhlendorf and Engle 2001, 2004). The most common fire-grazing management system in the Flint Hills region is annual spring burning followed by double stocking to enhance livestock gains (Owensby and Smith 1973), but other range management practices like patch-burn grazing are becoming more common. Patch-burn grazing management strives to restore landscape level heterogeneity and promote native plant diversity by burning different portions of a pasture over a multi-year time interval and thereby altering patch level grazing pressures within a given pasture (Fuhlendorf and Engle 2001, 2004; Fuhlendorf *et al.* 2006).

Fire alone has been shown to promote sericea lespedeza germination rates (Segelquist 1971), but a fire-grazing interaction such as seen with patch-burn grazing management has been shown to slow the expansion of sericea (Fuhlendorf and Engle 2001; Cummings et al. 2007). Our objectives for this study were 1) to evaluate the impact different burn management regimes had on fire litter load and subsequent fire temperatures, and 2) to determine the critical temperature to render sericea seeds unviable.

Methods

We examined the impacts of patch-burn grazing and annual-burn grazing management on fire temperature during prescribed spring fires in 2009 and 2010 at the Bressner Range Research Unit, Woodson County, Kansas. The site (253 hectares) is owned and operated by the Kansas State University Foundation, and consists of 4 replicate patch-burn grazing pastures, and 4 replicate annual-burn grazing pastures. Each pasture had one transect where litter load and fire temperature samples were collected. Litter load was estimated from litter clipped from 0.1 m^2 quadrats, and fire temperature was estimated using temperature sensitive paint (Tempilaq G®, ITW Company, South Plainfield, NJ) on aluminum plates placed underneath the litter layer and at 5 cm belowground. Sericea seed viability was determined using a tetrazolium respiration test on seeds that were heat treated for 1 and 2 minute intervals over 25 C temperature increments from 50-400 C.

Results and Discussion

Litter loads were significantly higher under patch-burn grazing management in both years with patch-burn grazing having at least 50% more litter than annual-burn grazing in both 2009 and 2010. Fire temperatures were significantly higher under patch-burn management in 2010, but not 2009. Environmental conditions likely influenced fire temperatures as conditions during the 2009. Fire conditions were extremely wet and cold during 2009, but fire conditions in 2010 were much drier and warmer. Seed viability tests indicate that temperatures greater than 325 C and 250 C for durations of 1 and 2 minutes, respectively, render sericea seeds nonviable (Figure 5). Median fire temperature was 250 C for the patch-burn grazed pastures during 2010, and 63.3% of the fire temperature plates reached 250 C (Table 1). We conclude that although some sericea lespedeza seeds on the ground surface may be damaged by spring fire in tallgrass prairie, most are likely to survive, and any seeds below the ground surface are likely protected from fire.

References

Cummings, D.C., Fuhlendorf, S.D., & Engle, D.M.. 2007. Is altering grazing selectivity of invasive forage species with patch burning more effective than herbicide treatments. *Rangeland Ecology and Management,* **60**, 253-260.

Dudley, D.M., & Fick, W.H. (2003) Effects of sericea lespedeza residues on selected tallgrass prairie grasses. *Transactions of the Kansas Academy of Science,* **106**, 166-170.

Eddy, T.A., & Moore, C.M. (1998) Effects of sericea lespedeza (Lespedeza cuneata (Dumont) G. Don) invasion on oak savannas in Kansas. *Transactions of the Wisconsin Academy of Sciences Arts and Letters,* **86**, 57-62.

Fuhlendorf, S.D., & Engle, D.M. (2001) Restoring heterogeneity on rangelands: ecosystem management based on evolutionary grazing patterns. *Bioscience*, **51**, 625-632.

Fuhlendorf, S.D., & Engle, D.M. (2004) Application of the fire-grazing interaction to restore a shifting mosaic on tallgrass prairie. *Journal of Applied Ecology,* **41**, 604-614.

Fuhlendorf, S.D., Harrell, W.C., Engle, D.M., Hamilton, R.G., Davis, C.A., & Leslie, D.M., Jr. (2006) Should heterogeneity be the basis for conservation? Grassland bird response to fire and grazing. *Ecological Applications,* **16**, 1706-1716.

KSDA. (2011) Kansas Department of Agriculture Sericea Lespedeza Control Program. http://www.ksda.gov/plant_protection/content/349/cid/579 *Accessed October* 20, 2011.

Kalburtji, K. L., & Mosjidis, J.A. (1993) Effects of sericea lespedeza root exudates on some perennial grasses. *Journal of Range Management,* **46**, 312-315.

Ohlenbusch, P.D., Bidwell, T., Fick, W.H., Scott, W., Clubine, S., Coffin, M., Kilgore, G., Davidson, J., & Mayo, J. (2007) Sericea lespedeza: history, characteristics, and identification. Manhattan, KS, USA: Kansas State University Agriculture Experiment Station and Cooperative Extension Service, MF-2408.

Owensby, C.E., & Smith, E.F. (1973) Burning true prairie. *Third Midwest Prairie Conference,* **3,** 1-4.

Segelquist, C.A. (1971) Moistening and heating improve germination of two legume species. *Journal of Range Management,* **24**, 393-394.

USDA, NRCS. (2011) Sericea lespedeza. *The PLANTS Database.* http://plants.usda.gov. Accessed October 20, 2011.

Woods, T.M., Hartnett, D.C., & Ferguson, C.J. (2008) High propagule production and reproductive fitness homeostasis contribute to the invasiveness of *Lespedeza cuneata* (Fabaceae). *Biological Invasions,* **11**, 1913-1927.

Table 1. Percent of fire temperature plates reaching minimum thresholds lethal to sericea lespedeza seeds from prescribed burn event in April 2009 and 2010 at the Bressner Range Research Unit, Woodson County, KS.

		Temperature Thresholds	
		>250 C	>325 C
2009			
	Patch-burn	16.7%	3.3%
	Annual-burn	10.0%	1.7%
2010			
	Patch-burn	63.3%	28.3%
	Annual-burn	26.7%	1.1%

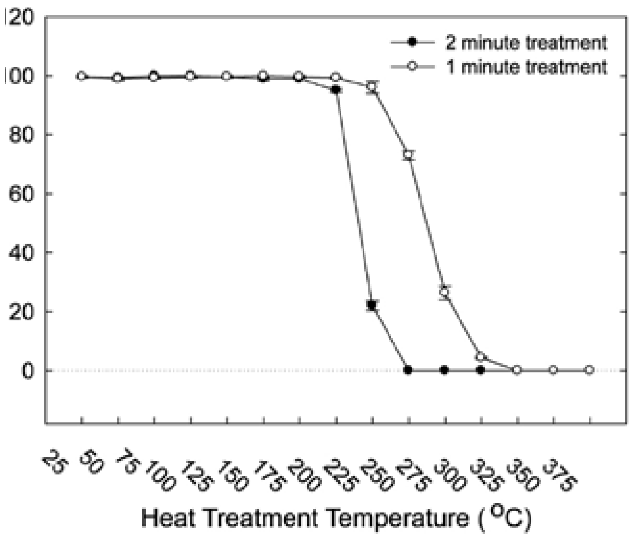


Figure 5. Sericea lespedeza seed viability in response to heat treatments of 1 and 2 minute durations. Points are the percent of viable seeds of 3 100-seed replicates at each temperature treatment.

Responses of a Pacific Northwest Bunchgrass Food Web to Experimental Manipulations of Stocking Rate

Presenter: Patricia L. Kennedy, Oregon State University (pat.kennedy@oregonstate.edu)

Other Authors: Timothy DelCurto, Sandra J. Debano, Tracey N. Johnson, Samuel Wyffels, Chiho Kimoto, and Ryan Limb, Oregon State University; Robert V. Taylor, The Nature Conservancy; Heidi Schmalz, University of Idaho

Introduction

Livestock graze the majority of rangelands globally, contributing $74 billion in business to many rural economies and forming a major component of US agricultural production (USDA-ERS 2010). However, sustainable livestock production on the country's rangelands is currently limited by our incomplete knowledge of the impact of grazing on ecosystem services associated with rangelands, including those provided by native fauna. Vegetative changes resulting from grazing are used to explain varying patterns of biodiversity in grazed and ungrazed areas. However, the effects of livestock grazing on animals (both vertebrates and invertebrates) is poorly understood because the majority of livestock grazing studies only involve plants, abiotic environments and livestock (see reviews by Milchunas et al. 1998, Olff and Ritchie 1998, Stohlgren et al. 1999, Jones 2000). There is less quantitative data on invertebrate and wildlife responses to different livestock grazing management scenarios. To fully understand effects of livestock grazing on ecosystems, effects on other rangeland occupants cannot be ignored. We need to expand our livestock grazing investigations beyond the obvious changes in plants, and pay attention to potential bottom-up effects (both direct and indirect) on other herbivores and consumers. Experimental studies are needed that evaluate livestock grazing effects on terrestrial food webs with multiple trophic levels and taxonomically diverse consumers (invertebrates and vertebrates) (Polis et al. 2004).

Approach

Study Ecosystem

We conducted this experiment at The Nature Conservancy's (TNC) Zumwalt Prairie Preserve (ZPP) in northeastern Oregon (lat 117° 3' N, long 45° 31'W); ZPP is located on the largest relict (approx 65,000 ha) of the Pacific Northwest Bunchgrass Prairie in North America, an ecosystem type which once covered approximately 800,000 ha in the northwestern United States and Canada. Compared to other prairies in North America, relatively little is known about these semi-arid temperate grasslands as the majority disappeared quickly after Euro-American settlement (Bartusevige et al. *in press*). Because the Zumwalt Prairie is slightly higher, drier, colder and more geographically isolated than other bunchgrass prairies in western North America it has remained relatively intact. Little of the prairie has been farmed, and spring/summer cattle grazing is the primary land use.

Most previous investigations of livestock grazing have been conducted in areas that have evolved in the presence of extensive herds of large native herbivores [e.g., bison *(Bison bison)].* Grasslands and their associated fauna, which evolved in the presence of large herbivores, are expected to be relatively insensitive to, or even dependent upon, grazing by domestic livestock compared to grasslands that supported few large herbivores in the Holocene (Milchunas and Lauenroth 1993, Stohlgren et al. 1999, Pykala 2000). In addition the study site (like approximately 75% of the western US) is characterized by high elevation rangelands (> 1000 m), short growing seasons (< 150 days), and relatively low annual precipitation (< 50 cm). Thus, arid, mountainous grasslands such as those in the study area are more likely to show a different treatment effect to livestock stocking rate experiments than grasslands that have a long history of native ungulate herbivory, more precipitation and longer growing seasons (Adler et al. 2004).

Our study organisms for this experiment were selected members of the grassland food web which included vascular plants, terrestrial invertebrates, and breeding songbirds and their predators. Members of both animal taxa (invertebrates and birds) are providers of important ecosystem services. Invertebrates are involved with a wide variety of supporting services, including providing pollination for native and agriculturally important plants, pest control through the actions of natural predators, and as food resources for other organisms, including birds. Breeding grassland birds also provide a number of ecosystem services, including cultural services because society values their existence for aesthetic reasons, and regulating services because of their important roles as both predators and prey. Both groups are also known to be sensitive to changes in soil and vegetation characteristics that are impacted by grazing. North American grassland bird populations have shown dramatic declines in recent years and appear to be declining more markedly than all other avian guilds on this continent (Sauer and Link 2011).

Experimental Design
We used a randomized complete block design with one factor (livestock grazing) and four grazing treatment levels (stocking rate) to evaluate our predictions. Details on the experimental design are presented in Table 2 and Johnson et al. *in press.*

Summary of Results
The results of this experiment are summarized for each trophic level below.

• *Soils:* Penetration resistance (i.e., compaction) increased at medium and high stocking rates relative to paddocks with low stocking rates or no cattle. While herbaceous litter increased across the study area, increases were greater in ungrazed and lightly grazed paddocks (22% and 18%, respectively) than in areas experiencing moderate to high grazing (mean increase of 9.6% and 9.5%, respectively. Aggregate soil stability was reduced in the soil sub-surface when exposed to moderate or high stocking rates relative to lightly grazed or areas excluded from livestock grazing (Schmaltz 2011).

• *Plants:* Overall paddock-level visual obstruction (our index of vegetation structure) decreased and structural heterogeneity increased with increasing stocking rates, and those effects carried over one year after grazing had ceased (Johnson et al. in review a). There were no significant effects of stocking rates on plant composition (Limb et al., unpublished data).

• *Invertebrates:* Invertebrate taxa varied in their resistance to livestock grazing intensity. Several common taxa (e.g., grasshoppers and leafhoppers) were highly resistant – showing no response to grazing treatment. Other taxa, including native bees, spiders, and Lepidoptera showed decreases in abundance and diversity and changes in community composition with increased grazing intensity, with some responses evident even at fairly low levels of grazing intensity (~20% utilization) (Kimoto 2011).

• *Birds:* The high stocking rate had a negative effect on bird and nest abundance of several species and avian community composition differed between control and heavily-grazed paddocks. Although stocking rate influenced vegetation structure, the only nest failures related to stocking rate were from trampling. Trampling rates were higher in paddocks with more cattle, but also depended on number of days cattle were present (Johnson et al. in review a, b).

Discussion
The soil and vegetation results suggest significant and potentially long-term changes caused by livestock grazing can occur. High stocking rates had significant effects on all food web components. However, the changes in soil properties and vegetative structure observed in the low to moderate stocking rates did not have significant effects on higher vertebrate trophic levels. The persistence of these changes is not known because we only applied treatments for two years. In addition, we do not know how the rate of removal influences the development of thresholds and responses of faunal communities in this system. This will be examined in future research.

References
Adler, P. B., Milchunas, D.G., Lauenroth, W.K., Sala, O.E., Burke, I.C. (2004) Functional traits of graminoids in semi-arid steppes: a test of grazing histories. *Journal of Applied Ecology* **41**, 653-663.

Bartuszevige, A. B, P. L. Kennedy and R. V. Taylor. In press. Sixty-seven years of landscape changes in the last, large remnant of the Pacific Northwest Bunchgrass Prairie. *Natural Areas Journal.*

Johnson, T. N., P. L. Kennedy, T. DelCurto and R. V. Taylor. In press. Bird community responses to cattle stocking rates in a Pacific Northwest bunchgrass prairie. *Agriculture, Ecosystems & Environment.*

Johnson, T. N., P. L. Kennedy, and M. A. Etterson. In review. Estimating risk of cause-specific nest-failure for grassland passerines in experimentally-grazed paddocks. *Journal of Wildlife Management.*

Jones, A. (2000). Effects of cattle grazing on North American arid ecosystems: A quantitative review. Western North *American Naturalist* **60**, 155-164.

Kimoto, C. (2011) Effect of livestock grazing on native bees in a Pacific Northwest Bunchgrass prairie. M.S. Thesis, Oregon State University, Corvallis, Oregon, USA.

Milchunas, D.G. and W. K. Lauenroth. (1993) Quantitative effects of grazing on vegetation and soils over a global range of environments. *Ecological Monographs* **63**, 327-366.

Milchunas, D. G., W. K. Lauenroth, and I. C. Burke. (1998) Livestock grazing: animal and plant biodiversity of shortgrass steppe and the relationship to ecosystem function. *Oikos* **83**, 65-74.

Olff, H., and M. E. Ritchie. (1998) Effects of herbivores on grassland plant diversity. *Trends in Ecology and Evolution* **13**, 261-265.

Polis, G. A., M. E. Power, and G. R. Huxel, Editors. (2004) *Food webs at the landscape level.* University of Chicago Press, Chicago, Illinois, USA.

Pykala, J. (2000) Mitigating human effects on European biodiversity through traditional animal husbandry. *Conservation Biology* **14**, 705-712.

Sauer, J.R. and W. A. Link. (2011) Analysis of the North American Breeding Bird Survey using hierarchical models. *Auk* **128**, 87-98.

Schmalz, H. (2011) Soil spatial heterogeneity and measured soil responses: factors in an ecological grazing experiment on a bunchgrass prairie. M. Sc. Thesis. University of Idaho, Moscow, Idaho, USA.

Stohlgren, T.J., Schell, L.D., Heuvel, B.V. (1999) How grazing and soil quality affect native and exotic plant diversity in Rocky Mountain grasslands. *Ecological Applications* **9**, 45-64.

(USDA-ERS) United States Department of Agriculture Economic Research Service. (2010) U.S. beef and cattle industry: Background statistics and information. www.ers.usda.gov; last accessed May 26, 2011.

Wyffels, S. (2009) Influence of stocking density on grazing beef cattle performance, diet composition, foraging efficiency, and diet quality on a late-spring early-summer native bunchgrass prairie. M.Sc. Thesis, Oregon State University, Corvallis, Oregon, USA.

Table 2. Phase I grazing treatments randomly assigned to each 40-ha paddock within each block (n =4) on the Zumwalt Prairie Preserve, northeastern Oregon, USA.

Treatment	Animal unit months[b]	Mean Percent Utilization[c] (SD)
Control[a]	0.00	9.52 (3.05)
Low	14.4	20.18 (4.08)
Moderate	28.8	31.66 (5.72)
High	43.2	46.09 (11.68)

a Control treatments represented no use by domestic livestock. However, native herbivores (e.g., ungulates, insects) were present in control paddocks. We present mean utilization for control paddocks to account for background levels of native herbivory at the study site.
b One animal unit is defined as a mature cow and calf. We assume each animal unit consumes 20 kg/day and a grazing period of 42 days.
c Utilization was averaged over the two treatment years (2007-08). Methods for determining utilization are presented in Wyffels (2009).

3

Climate Change and Grasslands

Credit: Whitney Tawney, Ducks Unlimited.

"Grassland and wetland area in the Dakotas has been declining since settlement by European immigrants a century and a half ago. Strike one against this natural capital was the plowing up and farming a large portion of the grassland acreage; strike two was draining nearly half of the prairie wetlands; strike three may be climate change. Or will it?"

–Johnson, W.C. 2011. Keynote Address: Dakota grasslands, wetlands, and climate change: Last nail or silver lining? *Proceedings of the South Dakota Academy of Science,* **90**: 29.

Preparing the prairies: using applied science to prioritize climate adaptation activities in the Northern Great Plains

Presenter: Anne M. Schrag, World Wildlife Fund (anne.schrag@wwfus.org)

Climate change is impacting all corners of the planet in varying degrees and is changing the face of conservation in the process. While much of the focus on climate change impacts has been and continues to be on systems that represent climatic extremes, the high biodiversity and ecosystem services that are present in temperate grasslands suggest that focusing attention on impacts and adaptation strategies in these areas is also highly valuable. The Northern Great Plains represents a unique opportunity to implement climate adaptation practices on the ground, using applied science as a mechanism for prioritizing activities across the region.

In this presentation, I presented our findings on climate change impacts to the region at multiple scales and described how these findings will be translated into climate adaptation activities on the ground. I began by describing ecoregional-scale findings on climate exposure in the Northern Great Plains. In collaboration with The Nature Conservancy, WWF's Northern Great Plains Program has completed a study that describes average change over the past 50 years (1951-2002) and projected change by the middle of the century (2050s; Schrag 2011). This study showed that temperatures have increased by up to almost 5°F in some areas of the Northern Great Plains over the last 50 years and that temperatures are likely to continue to increase, by up to 10°F in some areas. On average across the region, summers and falls are expected to be warmer and drier, while springs are expected to be warmer and wetter.

I then presented the results of two data-driven models that we have used to prioritize climate adaptation activities in the region. The first study examined the impacts of projected climate change on sagebrush habitat and West Nile virus occurrence in the region. Our models suggest that areas with the highest future suitability for sagebrush habitat will be found in southwestern Wyoming and north-central Montana. The West Nile virus degree-day model suggests that greater sage-grouse in western portions of the study area, which are generally higher in elevation than where West Nile virus currently occurs, will see increasing risk of transmission in the future. We developed a spatially explicit map of suggested management actions based on our predictions that will aid in conservation of the species into the coming decades (Schrag *et al.* 2010).

The second study I presented focuses on developing scientifically based models of the impacts of climate change on forage productivity, or the amount of grass produced, in priority landscapes of the Northern Great Plains. Our preliminary results suggest that all three global circulation models that we used—cool/wet, medium, hot/dry—will cause overall decreases in the amount of forage produced in 2030 in the two landscapes. Even in the "wet" scenario, overall precipitation decreases compared with the current average, and we suspect the decreases during optimal growth periods (May-July) may be driving the predicted decreases. Changes appear to be more dramatic for western South Dakota than for eastern Montana, especially under the medium and dry scenarios. In some locations, decreases of up to 3000 lbs/acre are predicted in eastern Montana and up to 2300 lbs/acre in western South Dakota. Current estimates suggest that the most productive lands in eastern Montana produce 5700 lbs/acre and in western South Dakota produce 2800 lbs/acre.

Decreasing the amount of forage available for wildlife and production animals by over 50% is likely to have an enormous impact on wildlife populations and the sustainability of livelihoods in a region that is dominated by cattle ranching. To put these numbers in perspective, according to numbers from Ducks Unlimited Canada on grass production in Manitoba (a similar climate to our eastern Montana landscape), a 1400 lb cow consumes approximately 7200 lbs during the six month growing season. Thus, under historic conditions, the top grass-producing areas in eastern Montana would support cattle grazing at a rate of 1.26 acres/head of cattle. Under future conditions, landowners can expect to need 2.0 acres/head of cattle. This equates to a 60% increase in the amount of land needed to maintain the same number of cattle under climate change.

Overall, the capacity of the land to provide food for both wildlife and livestock is predicted to decrease in the future, with some areas impacted more greatly than others. Decreases in western South Dakota are likely to have a greater impact on both wildlife and livestock due to the smaller amount of forage currently produced on those lands. Some areas in the southeastern part of the western South Dakota landscape may become completely uninhabitable by species that are dependent on grass production for food. Other areas, mostly in the eastern Montana landscape, may see neutral to positive impacts from climate change, at least in the next two decades.

Together, these studies represent a scientifically driven method for prioritizing climate adaptation activities on the ground at a landscape to regional scale. While all models have drawbacks, they also represent a method for prioritizing limited resources on the ground in a defensible way. We also believe that linking models to human and economic impacts will help to increase their acceptance among different audiences.

References

Schrag, A.M. (2011) Addendum: climate change impacts and adaptation strategies. In: Ocean of grass: a conservation assessment for the Northern Great Plains. Eds., Forrest, S.C., Strand, H., Haskins, W.H., Freese, C., Proctor, J., Dinerstein, E. Northern Plains Conservation Network and Northern Great Plains Ecoregion, World Wildlife Fund-US, Bozeman, MT.

Schrag, A.M., Konrad, S.K., Miller, S.N., Walker, B.L., Forrest, S.C. (2011) Climate-change impacts on sagebrush habitat and West Nile virus transmission risk and conservation implications for greater sage-grouse. *GeoJournal,* **76(5),** 561-575.

Phenological changes on the prairie: Long-term trends in spring arrival dates of migratory waterfowl and other birds in south-central North Dakota

Presenter: Lawrence Igl, USGS Northern Prairie Wildlife Research Center (ligl@usgs.gov)

Phenological studies have proven useful in evaluating the responses of animals and plants to changes in temperature. Most bird species that breed in the northern Great Plains of North America are migratory, spending nearly one-half to three-quarters of their annual cycle in areas south of their breeding range. Other boreal and tundra breeding birds pass through this region during migration. Warmer spring temperatures in this region may be expected to result in earlier spring arrivals of migratory birds. Published documentation of such patterns is sparse for the Great Plains. A phenological study of springtime arrivals of waterfowl and other migratory birds was made over a 40-year period (1965-2004) in Stutsman and surrounding counties in south-central North Dakota. For this evaluation, migrant species were included only if their recorded arrival dates included 25 or more of the study years; 53 species met this criterion. The Julian dates of first arrivals for each of these species were linearly regressed against year. Thirty-nine of the 53 species showed a significant trend ($P < 0.05$) toward earlier arrival (average 13.7 days earlier + 0.8 SE). The extent of advancement in spring arrival varied greatly among species. For example, of 20 waterfowl species evaluated over the 40-year period, 16 had significantly advanced the timing of their spring arrival (average 16.5 days earlier + 1.3 SE). In contrast, two grassland-nesting shorebirds (Marbled Godwit and Upland Sandpiper) showed no trend in arrival dates through time. The arrival dates of 29 (67.9%) of the 53 species were negatively related ($P < 0.05$) to temperature, indicating that these species arrived earlier as spring temperatures increased. I discuss phenological adaptability and evaluate the relationship between arrival date and mean temperature for the month of arrival. Given that phenological events are frequently used in natural resources management (e.g., timing of spring prescribed fires), game harvest regulations (e.g., timing of spring white goose season), and research and monitoring (e.g., timing of lek counts or breeding bird surveys), the results from this study suggest that more attention should be given to the ecological importance of climatic warming in the management and conservation of migratory birds in the northern Great Plains.

Opportunities and Barriers for Grasslands in Greenhouse Gas Markets

Presenter: Randal Dell, Ducks Unlimited (rdell@ducks.org)

Opportunities for grasslands to participate in carbon finance have been limited to date relative to those afforded to cropland and forested systems, although progress is underway in demonstrating that North American grassland-based greenhouse gas (GHG) mitigation projects are feasible, cost-effective and scalable. Given the vast number of grassland acres in North America, and the low-intensity management on many of these acres, opportunities to increase greenhouse gas sequestration and storage for use in carbon markets would appear sizable. Indeed, estimates of the collective potential of these practices indicate that U.S. grasslands could annually mitigate 29.5-110.0 Million Metric Tons of Carbon per year, potentially offsetting up to 5% of annual U.S. emissions (Follet *et al.* 2001). However, economic and competitive constraints with other land-based mitigation strategies are estimated to limit the extent to which grassland-based GHG mitigation projects are viable (Antle *et al.*2003; Capalbo et al. 2004; McCarl *et al.* 2009). Numerous grassland-based activities leveraged through carbon finance can still play a role in a comprehensive GHG mitigation strategy, even when economic and competitive constraints are considered (Creyts *et al.* 2007). Two of the primary remaining barriers to wider expansion for grassland-based carbon finance opportunities are the lack of eligibility of grassland projects in major standard certification programs and limited carbon offset demand to encourage broader project investment.

Standards play an essential role in voluntary and regulatory carbon markets as they provide a transparent and independent accreditation process that gives value and the commoditization of a greenhouse gas reduction benefit as a carbon offset (Bayon et al. 2007). Three primary quantitative standards have come to dominate in importance for the certification of North American biological offsets: the American Carbon Registry, the Climate Action Reserve and the Verified Carbon Standard. Recognition and opportunities for grassland-based projects in these programs have either not been available or not widely implemented. To date, neither the American Carbon Registry nor the Climate Action Reserve has developed grassland applicable methodologies or protocols. The Verified Carbon Standard (VCS) differs from the other programs in that it has a bottom-up approach to methodology development, where project proponents or others develop and submit methodologies of approved project types to be approved by the VCS. Eligible VCS project categories applicable to grasslands include: Improved Grassland Management; Agricultural Land Management, i.e. Cropland and Grassland Land-use Conversion; and Avoided Conversion of Grasslands and Shrublands. Several grassland methodologies have been submitted for approval to the VCS, or are in the process of being developed, with pilot projects underway to test the feasibility of these programs for use in North America. If successful, methodologies and protocols for the other standard programs could be developed.

In the absence of a Federal regulatory carbon market, market demand for North American produced biological carbon offsets has been primarily limited to the voluntary market and some limited speculative investment in burgeoning regional programs. The size of the maturing, but still nascent, voluntary carbon market has trended upwards over the past decade, peaking in 2008 at an estimated $755 million in transacted offsets (Peters-Stanley *et al.*2011). Many of the buyers active in the purely voluntary market are interested in pursuing Corporate Socially Responsibility objectives, of which the many co-benefits of grasslands to wildlife, the environment and communities would figure to be attractive. A separate market largely uninterested in secondary benefits of carbon offsets are speculative and regulated entities purchasing carbon offsets for use in regional regulatory programs, which have forged ahead in the absence of a Federal program. The two programs having the greatest impact on market activity at the moment are California's AB32 program and the Western Climate Initiative. Program specifics are still being refined but early estimates of California's AB32 program project demand for 180 million offsets for use from 2012-2020, commanding up to $18 per offset by 2016 (unpublished data, Carbon Credit Capital LLC).

Grass-based producers have already demonstrated a willingness to implement management practices and participate in offset programs given straightforward requirements and a sufficient price signal, via the recent Chicago Climate Exchange. Additional opportunities for carbon finance to leverage grassland management and conservation should be anticipated to improve given current momentum in regional carbon-related policy, broader project demonstration and methodology development, and projected growth in demand for grassland-derived offsets in both voluntary and regulatory programs. The largest driver for these opportunities in North America in the immediate future will largely rest with the success of California's AB-32 program. Continued research and collaboration among grassland advocates to refine and promote grassland-based offset projects will still be needed to realize the potential of carbon finance to benefit North America's grasslands.

References

Antle, J.M., Capalbo, S.M., Mooney, S., Elliot, E.T., & Paustian, K.H. (2003) Spatial heterogeneity, contract design, and the efficiency of carbon sequestration policies for agriculture. *Journal of Environmental Economics and Management,* **46**, 231–250.

Bayon, R., Hawn, A., Hamilton, K. (2007) *Voluntary Carbon Markets. An International Business Guide to What They Are and How They Work.* Earthscan, London.

Capalbo, S.M., Antle, J.M., Mooney, S., & Paustian, K.H. (2004) Sensitivity of carbon sequestration costs to economic and biological uncertainties. *Environmental Management,* **33(1),** 238–251.

Creyts J, Derkach A, Nyquist S, Ostrowski K, Stephenson J (2007) *Reducing U.S. greenhouse gas emissions: How much at what cost?* New York: McKinsey and Company.

Follet, R.F., Kimble, J.M. & Lal, R. (2001) The Potential of U.S. Grazing Lands to Sequester Soil Carbon. *The Potential of U.S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect* (eds. R.F. Follet, J.M. Kimble & R. Lal) pp. 401-432. CRC Press, Boca Raton, FL USA.

McCarl, B.A. & Sands, R.D. (2007) Competitiveness of terrestrial greenhouse gas offsets: are they a bridge to the future? *Climatic Change,* **80**, 109-126.

Peters-Stanley, M., Hamilton, K., Marcello, T. & Sjardin, M. (2011) Back to the Future: *State of the Voluntary Carbon Markets 2011.* Ecosystem Marketplace & Bloomberg New Energy Finance.

Integrating Climate Change Risk into the Evaluation of Habitat Program Efficacy: Conservation Program Contributions to Grassland Bird Conservation in the Context of Projected Climate Change

Presenter: Duane Pool, Rocky Mountain Bird Observatory (duane.pool@rmbo.org)

The short- and central mixed-grass prairie ecoregions have evolved to cope with a dynamic climate of drought and wet periods, as have the grassland bird species that inhabit the region. Key factors influencing abundance, distribution, and vital rates of grassland bird species are changes in food resources, habitat patch size, and vegetation structure. Climate change is another potential source of habitat shifts. Potential shifts may result from changes in vegetation structure and composition due to changes in precipitation and temperature. Such changes may impact grassland birds; however, predicted impacts will vary depending on the species. To integrate the potential for climate driven habitat shifts in conservation planning we assessed historical (pre-2000) and future (2010 - 2060) climate conditions in the short and central mixed-grass prairie ecoregions and projected changes in vegetation structure.

The first step was to assess historical (2000) and future (2060) climate conditions in the short- and central mixed-grass prairie ecoregions. We obtained Atmosphere-Ocean General Circulation Models (AOGCM) projections of historical and future climate from the World Climate Research Programme. We evaluated the historical runs from each AOGCM and we selected the Hadley Model because it simulated the major influences to the short- and central mixed-grass prairie ecoregions better than the other available models. We derived climate change data using the high emissions scenario (A2) because current reports indicate the earth's emissions trajectory is more consistent with the higher CO^2 emissions scenario compared to lower emissions scenarios (e.g., A1, B1).

The second step was to use the derived climate data to project historical (2000) and future (2060) grassland conditions using the MC1 dynamic vegetation model. The MC1 dynamic vegetation model (Bachelet et al. 2001) projected the amount of above-ground carbon in a plant community given a set of ecological processes (e.g., disturbance, such as fire; variation in precipitation; temperature extremes). By changing the magnitude of a process (e.g., more extreme temperatures, more extreme precipitation events), we projected differences in above-ground carbon values. We related these changes in above-ground carbon values to changes in plant community structure (e.g., community dominated by grasses or shrubs) and productivity (e.g., height of grass). Changes in plant community or productivity can have beneficial or detrimental impacts for bird species that have historically used these areas for breeding, brood rearing, migrating and wintering habitat.

Annual average temperatures were predicted to increase in the short- and central mixed-grass prairie ecoregions. Temperatures in the short- and central mixed-grass prairie ecoregions were predicted to increase approximately 2.6 – 3.1 ° C above historical (2000) average temperatures by the year 2060. The greatest increase was projected to occur in Colorado, Kansas, Oklahoma and the northeast Panhandle of Texas.

Precipitation was predicted to decrease in the short- and central mixed-grass prairie ecoregions. Precipitation in the short- and central mixed-grass prairie ecoregions was predicted to decrease by approximately 32 mm/yr compared to historical (2000) precipitation. The greatest decrease was expected in the central portion of the short- and central mixed-grass prairie ecoregions.

The MC1 vegetation model projected that above-ground carbon will decline throughout much of the short- and central mixed-grass prairie ecoregions over the next 60 years, indicating a decrease in vegetation biomass in grassland habitat. The models estimated a reduction of 13 percent (3 g/m2) in above ground carbon throughout the short- and central mixed-grass prairie ecoregions. Overall, 84 percent of the short- and central mixed-grass prairie ecoregions are projected to have reduced above-ground carbon by 2060. The MC1 model predicted an eastward shift in vegetation carbon levels such that carbon levels historically occurring in the shortgrass prairie shift east into the central mixed-grass prairie in 60 years.

Spatially explicit information on future landscape conditions, such as that provided through this assessment, can assist natural resource managers in making informed decisions regarding strategic conservation delivery such as where to target habitat management activities, Farm Bill program enrollment and incentives, and even land acquisition. Targeted delivery of conservation programs that establish grassland habitat can help offset potential climate-induced changes to grassland bird habitat. Climate and vegetation models can be used to maximize offsets by providing insight as to where and what kind of changes are most likely to occur.

Little bluestem seedheads. Credit: Lynn Betts, NRCS.

4

Grassland Management and Bird Populations

Marbled godwit. Credit: K. Ellison, Wildlife Conservation Society.

"More than 97% of the native grasslands of the U.S. have been lost, mostly because of conversion to agriculture. As a result, grassland bird populations have declined from historic levels far more than any other group of birds."

–North American Bird Conservation Initiative, U.S. Committee, 2011. The State of the Birds 2011 Report on Public Lands and Waters. U.S. Department of Interior: Washington, DC.

Grassland bird conservation in working landscapes: research in progress

Presenter: Marisa Lipsey, University of Montana (mklipsey@gmail.com)

Other Authors: David E. Naugle and Richard Hutto, University of Montana

Introduction

Grasslands are one of the most threatened terrestrial biomes in the world (Hoekstra et al. 2004, CEC and TNC 2005). A catastrophic loss of grassland habitat in North America has resulted in a widespread decline of endemic grassland bird species over recent decades (Knopf 1996, Sauer et al. 1996, Brennan and Kuvlesky 2005). Several formerly wide-ranging grassland species are currently under consideration or are listed as federally endangered. The majority of habitat remaining for grassland birds in the Northern Great Plains is managed as productive rangeland. Sustainable livestock grazing is compatible with wildlife conservation (Derner et al. 2009); however, the dominant management paradigm of moderate and uniform use of forage for stable livestock production can negatively affect birds that select either relatively tall/dense or relatively short/sparse vegetation (Fuhlendorf and Engle 2001). The literature on grassland bird habitat selection emphasizes the importance of habitat heterogeneity to provide for multiple species with diverse habitat requirements. However, this represents a vague management prescription and it is unclear how such "heterogeneity" should be implemented. In particular, the literature does not address the spatial or temporal scale of heterogeneity appropriate for maintaining the full suite of grassland species.

Methods and Approach

This project aims to characterize the response of grassland bird species to variation in grassland structure across multiple spatial scales. We investigate habitat selection by birds in the mixed-grass prairie of eastern Montana at range, regional, ranch, and pasture level scales. We survey birds using 10-min, 100-m fixed-radius point counts, distributed across grasslands in two counties (Valley and Phillips counties). We also measure local vegetation characteristics within the 100-m radius survey area, including proportional grass cover and height and density of grasslands. We estimate grassland use by cattle at the time of sampling via dung counts along 200 x 2-m transects, with center points at bird survey locations.

We work closely with landowners and agency personnel to experimentally manipulate grazing and assess its effect on bird habitat selection. Our design at the ranch scale is centered on a set of six pairs of treatment pastures distributed widely across the study region. In each pair of pastures, we modify cattle use above or below the standard, moderate level, and then assess effects of resulting changes in grassland structure on bird distribution and abundance. Effects of the first year of grazing treatments on grassland structure will be measured in Fall 2011. At the pasture scale, we use distance to cattle watering points as a proxy for grazing pressure within a single pasture, predicting that areas closer to water are grazed earlier and more intensively than points farther from water. We survey birds and vegetation attributes across a set of distance intervals around water sources to identify gradients in grassland structure resulting from differential grazing pressure and to characterize bird response to these differences. We use four distance classes including 0-400 m, 401-800 m, 801-1200 m and >1200 m from water points, based on strong support in the literature that cattle will rarely walk farther than one mile (1600 m) from water to forage (Mackie 1970, Hart et al. 1993, Fusco et al. 1995).

Project Status and Preliminary Results

This research is in progress, and is currently at the end of the first full year of data collection. We are compiling data for range-wide habitat selection models via a collaborative network of agencies and institutions across Montana, North Dakota, Alberta and Saskatchewan. Preliminary range scale results are expected by 2013, with full results by 2014. Preliminary analyses of 2011 regional data identify a group of grassland specialist species whose occupancy corresponds closely with grassy habitats as opposed to shrub lands or badland habitats (Figure 6). Findings also support expected preference patterns for either relatively tall/dense or short/sparse grassland at local scales (Figure 6). Although interesting, local vegetation variables alone explained relatively little variation in the dataset compared to broad-scale attributes including grassland abundance within a ≥1 km of survey points.

In future analyses we will use a hierarchical information-theoretic approach and variance decomposition techniques to analyze habitat selection using local-scale habitat variables measured in the field and landscape-scale variables derived with a GIS (Doherty et al. 2010). We will evaluate relationships between habitat features that can and cannot be mapped in a GIS to provide insights into interpretation of landscape-scale-only GIS models. We plan next to produce habitat selection models at local and landscape scales, or both, depending upon which scale(s) explain the variation in bird use. We will use variance decomposition as a primary indicator of which scales explain the most pure and shared variation across scales in grassland bird habitat selection.

Grazing treatments were in place throughout Summer and Fall 2011, and bird responses to treatments at the ranch scale will be measurable for the first time in Spring 2012.

At the pasture scale, spring use by cattle was greatly reduced over 1200 m from water sources (average patties/transect within 1200 m = 48, outside 1200 m = 21; one-way ANOVA, $p = 0.001$). Cattle showed no differential use within 1200 m of water suggesting that water was not a limiting resource during the unusually wet spring in 2011. Similarly, we found no relationship between cattle use and resulting grass height or density. Instead, cattle use was associated with more grass and forb cover, and less bare ground and shrub or litter cover, suggesting that cattle may have been selecting for the highest quality forage. Grass was abundant and most likely not a limiting resource, thus no "piosphere" effect (*sensu* Lange 1969) around water holes was apparent. This result is not surprising given that sampling took place early in the growing season during an abnormally wet spring. Results of biomass sampling in Fall 2011 may lend additional insights into the role of water in shaping local grazing patterns.

References

Brennan, L. A. and W. P. Kuvlesky. (2005) North American grassland birds: An unfolding conservation crisis? *Journal of Wildlife Management* **69,** 1-13.

CEC and TNC. (2005) *North American Grassland Priority Conservation Areas: Technical Report and Documentation.* Commission for Environmental Cooperation and The Nature Conservancy, Montreal, Quebec.

Derner, J. D., W. K. Lauenroth, P. Stapp, and D. J. Augustine. (2009) Livestock as Ecosystem Engineers for Grassland Bird Habitat in the Western Great Plains of North America. *Rangeland Ecology & Management* **62**,111-118.

Doherty, K. E., D. E. Naugle, and B. L. Walker. (2010) Greater Sage-Grouse Nesting Habitat: The Importance of Managing at Multiple Scales. *Journal of Wildlife Management* **74**, 1544-1553.

Fuhlendorf, S. D. and D. M. Engle. (2001) Restoring heterogeneity on ragelands: ecosystem management based on evolutionary grazing pressures. *BioScience* **51**, 625-632.

Fusco, M., J. Holechek, A. D. Tembo, and M. Cardenas. (1995) Grazing influences on watering point vegetation in the Chihuahuan desert. *Journal of Range Management* **48**, 32-38.

Hart, R. H., J. Bissio, J. W. Samuel, and J. W. Waggoner. (1993) Grazing systems, pasture size, and cattle grazing behavior, distribution, and gains. *Journal of Range Management* **46**, 81-87.

Hoekstra, J. M., T. M. Boucher, T. H. Ricketts, and C. Roberts. (2004) Confronting a biome crisis: global disparities of habitat loss and protection. *Ecology Letters* **8**, 23-29.

Knopf, F. L. (1996) Prairie Legacies-- Birds. Pages 135-148 *in* F. B. Samson and F. L. Knopf, editors. *Prairie Conservation: Preserving North America's Most Endangered Ecosystem.* Island Press, Washington, D.C.

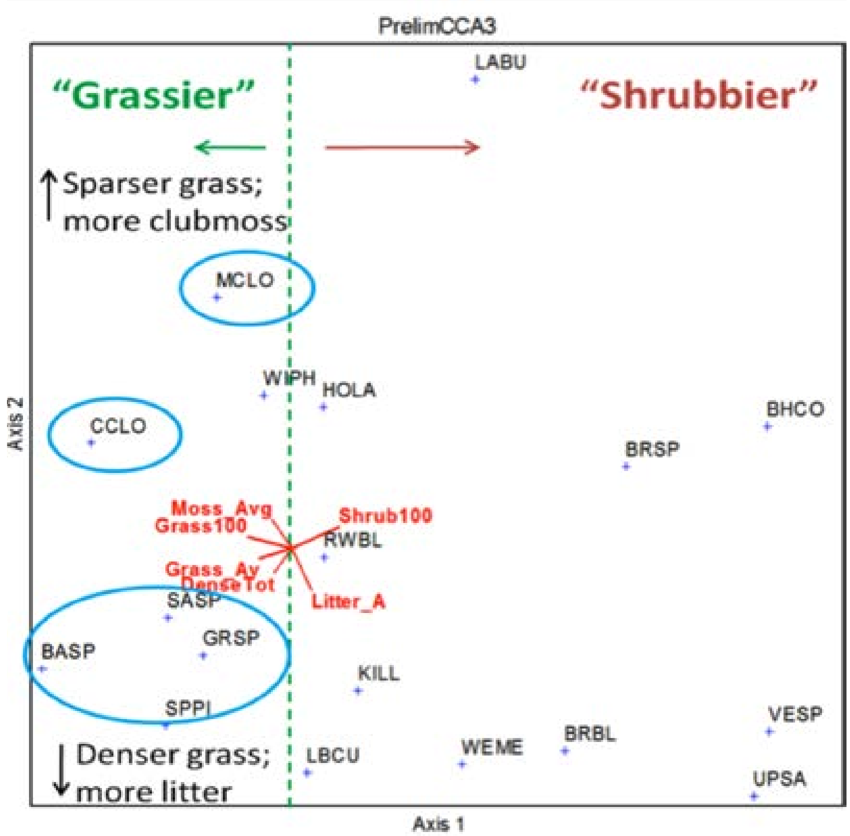


Figure 6. Canonical correspondence analysis of 18 common bird species in the study area *(BASP- Baird's Sparrow, BHCO- Brown-headed Cowbird, BRBL- Brewer's Blackbird, BRSP- Brewer's Sparrow, CCLO- Chestnut-collared Longspur, GRSP- Grasshopper Sparrow, HOLA- Horned Lark, KILL- Killdeer, LABU- Lark Bunting, MCLO- McCown's Longspur, RWBL- Red-winged Blackbird, SASP- Savannah Sparrow, SPPI- Sprague's Pipit, UPSA- Upland Sandpiper, VESP- Vesper Sparrow, WEME- Western Meadowlark, WIPH- Wilson's Phalarope)* against a reduced set of associated local vegetation variables *(Grass100= proportion grass cover within 100m radius circle, Grass_Av= average proportion grass cover in five, one-meter radius miniplots, DenseTot= total number of vegetative contacts on a Wiens pole at each of five miniplots, Litter_A= average proportion litter/dead grass cover in five, one-meter radius miniplots, Shrub100= proportion shrub cover within 100m radius circle, Moss_Avg= average proportion clubmoss cover in five, one-meter radius miniplots).* Species with a clear preference for "grassy" habitats are circled in blue.

Lange, R. T. (1969) The piosphere: sheep track and dung patterns. *Journal of Range Management* **22**, 396-400.

Mackie, R. J. (1970) Range ecology and relations of Mule Deer, Elk, and Cattle in the Missouri River Breaks, Montana. *Wildlife Monographs* **20**, 3-79.

Sauer, J. R., G. W. Pendleton, and B. G. Peterjohn. (1996) Evaluating causes of population change in North American insectivorous songbirds. *Conservation Biology* **10**, 465-478.

Effects of cattle stocking rate and grazing duration on songbirds of the mixed-grass prairie

Presenter: Maggi Sliwinski, University of Manitoba (maggi.sliwinski@gmail.com)

Other author: Dr. Nicola Koper, University of Manitoba

One third of the listed threatened or endangered species in Canada are grassland species (Samson and Knopf 1994), and most grassland bird species have experienced population declines over the past forty years (Knopf 1994). This has been attributed to habitat loss and degradation of the prairies (Samson and Knopf 1994, Askins et al. 2007), but also to more subtle changes caused by grazing regimes that differ from historical grazing patterns (Vickery et al. 1999, Coppedge et al. 2008). Although it would seem intuitive that native ungulates would be most effective for managing prairies for native biodiversity, studies have shown that cattle are an economically and ecologically viable alternative to bison (Plumb and Dodd 1993, Pieper 1994). However, current management of commercial livestock operations on mixed-grass prairies is aimed at homogenous use of the landscape (Biondini et al. 1999, Coppedge et al. 2008). Further homogenizing of the landscape has occurred because management on federal lands included a policy of grazing and fire exclusion, and provincial lands management was similar to private ranchland management (Parks Canada 2006). Thus, habitat conditions on both private and public lands do not support all endemic songbird species because many grassland birds require habitats other than those created by the common management practices (Wiens 1985, Temple et al. 1999, Vickery et al. 1999); specifically, relatively intensely disturbed or relatively undisturbed. Because of the lack of habitat created by other types of grazing regimes, it is important to introduce a grazing management plan that will help to restore those habitats required by all mixed-grass prairie species (Fuhlendorf and Engle 2001). Future management plans should foster a landscape that includes habitats with sparsely vegetated areas, heavily vegetated areas, and a range of vegetation characteristics in between. Through this study, I evaluated the effects of a range of stocking rates on habitat structure, songbird abundance, and songbird diversity in the northern mixed-grass prairie.

From 2006-2008, each of nine 300-ha pastures within the park were ungrazed. In 2009-2010, 6 pastures were grazed at a range of stocking rates (0.23, 0.36, 0.47, 0.54, 0.74, 0.82 AUM/ha), which were very low, average, and very high stocking rates for the area. Additionally, 3 sites were ungrazed controls (no cattle introduced for 2009-2010). I conducted songbird surveys from 2006-2010 and collected habitat structure measurements from 2008-2010. I used non-linear mixed models to determine effects of stocking rate, grazing duration, and the interaction between stocking rate and grazing duration on ten habitat structure variables, nine songbirds, and four songbird diversity measures. Pre-grazing data were also analyzed to determine if there were any patterns in habitat structure or songbird abundance in the pastures prior to grazing introduction, which is crucial for correlating the results with the treatments in ecological data (Underwood 1994). Information theory was used to determine the best-fitting model from a set of eleven candidate models; only models for which Δ AIC from null < 2 were selected because AIC tends to favors more complicated models (Quinn and Keough 2002).

The analysis using pre-grazing data from 2008 revealed that prior to grazing reintroduction, only litter cover had a pre-existing pattern, while all other variables had no patterns in the pastures prior to grazing. Vegetation height, canopy height, and litter depth decreased with stocking rate. Chestnut-collared longspurs increased in relative abundance with grazing, while grasshopper and Savannah sparrows decreased in abundance with grazing. Sprague's pipits and Baird's sparrows also decreased with grazing.

Although other studies have shown that Baird's sparrows and Sprague's pipits are insensitive to low and moderate levels of grazing (Davis et al. 1999, Koper and Schmiegelow 2006), our study showed that both species would benefit from grazing exclusion. Stocking rates can be used to modify habitat for the benefit of threatened songbird populations by both public and private land managers.

References

Askins, R. A., F. Chávez-Ramírez, B. C. Dale, C. A. Haas, J. R. Herkert, F. L. Knopf, and P. D. Vickery. (2007) Conservation of grassland birds in North America: Understanding ecological processes in different regions. *Ornithological Monographs,* **64**, 1-46.

Biondini, M. E., A. A. Steuter, and R. G. Hamilton. (1999) Bison use of fire-managed remnant prairies. *Journal of Range Management,* **52**, 454-461.

Coppedge, B. R., S. D. Fuhlendorf, W. C. Harrell, and D. M. Engle. (2008) Avian community response to vegetation and structural features in grasslands managed with fire and grazing. *Biological Conservation,* **141**, 1196-1203.

Davis, S. K., D. C. Duncan, and M. Skeel. (1999) Distribution and habitat associations of three endemic grassland songbirds in southern Saskatchewan. *Wilson Bulletin,* **111**, 389-396.

Fuhlendorf, S. D., and D. M. Engle. (2001) Restoring heterogeneity on rangelands: Ecosystem management based on evolutionary grazing patterns. *Bioscience*, **51**, 625-632.

Fuhlendorf, S. D., and D. M. Engle. (2004) Application of the fire-grazing interaction to restore a shifting mosaic on tallgrass prairie. J*ournal of Applied Ecology,* **41**, 604-614.

Knopf, F. L. (1994) Avian assemblages on altered grasslands. *Studies in Avian Biology,* **15**, 67-84.

Koper, N., and F. K. A. Schmiegelow. (2006) Effects of habitat management for ducks on target and nontarget species. *Journal of Wildlife Management,* **70**, 823-834.

Parks Canada. (2006) *Restoring grazing-induced heterogeneity in Grasslands National Park of Canada.* Grasslands National Park of Canada, Parks Canada, Val Marie, SK.

Pieper, R. D. (1994) Ecological implications of livestock grazing. *Ecological Implications of Livestock Herbivory in the West* (eds. M. Vavra,, W. A. Laycock, & R. D. Pieper), pp. 177-211. Society for Range Management, Denver, CO.

Plumb, G. E., and J. L. Dodd. (1993) Foraging ecology of bison and cattle on a mixed prairie: implications for natural area management. *Ecological Applications*, **3**, 631-643.

Quinn, G. P., and M. J. Keough. (2002) *Experimental design and data analysis for biologists.* Cambridge University Press, New York.

Samson, F., and F. Knopf. (1994) Prairie conservation in North America. *Bioscience*, **44**, 418-421.

Temple, S. A., B. M. Fevold, L. K. Paine, D. L. Undersander, and D. W. Sample. (1999) Nesting birds and grazing cattle: accommodating both on Midwestern pastures. *Studies in Avian Biology,* **19,** 196-202.

Underwood, A. J. (1994) On beyond BACI: sampling designs that might reliably detect environmental disturbances. *Ecological Applications,* **4,** 3-15.

Vickery, P. D., P. L. Tubaro, J. M. Cardoso da Silva, B. G. Peterjohn, J. R. Herkert, R. B. Cavalcanti. (1999) Conservation of grassland birds in the Western Hemisphere. *Studies in Avian Biology,* **19,** 2-26.

Wiens, J. A. (1985) Vertebrate responses to environmental patchiness in arid and semiarid ecosystems. *The Ecology of Natural Disturbance and Patch Dynamics* (eds. S. T. A. Pickett and P. S. White), pp. 169-196. Academic Press, San Diego, CA.

Impact of Three Common Grazing Strategies on Yearling Cattle Performance and Duck Production in South Dakota

Presenter: Randy Meidinger, Ducks Unlimited (rmeidinger@ducks.org)

Other authors: Bruce Toay and Johann Walker, Ducks Unlimited, Inc.

Many studies have been conducted to determine the effect different grazing strategies have on cattle performance, while other studies have been conducted to determine the impact such grazing practices have on duck production. However, few studies have been designed to investigate these two areas of interest in a precise common spatial and temporal setting. From 2009-2011 we investigated the impact three common grazing strategies (once-over four pasture rotation, twice-over four pasture rotation, and single pasture season-long grazing) had on yearling cattle performance, vegetation density, and duck production on the Ducks Unlimited Goebel Ranch in north-central South Dakota. Spayed yearling heifers (n = 1800 each year) of similar size were weighed prior to being placed randomly into designated pastures in early May, and were weighed again at the end of the 135 day grazing season. All thirty-five pastures (~160 ac each) included in the study were grazed at the same overall grazing intensity with ~3.1 acres allowed per heifer. During all years cattle grazing in a season-long scenario had the highest average daily gain (ADG), followed by cattle grazing in a twice-over rotation, while cattle grazing in a once-over rotation had the lowest ADG. Monitoring of vegetation density was conducted (Visual Obstruction Readings – VORs) throughout the season along randomly placed transects in all grazed pastures. Average VORs taken at the end of the season in the once-over system had higher overall readings than pastures in either the twice-over or season-long grazing strategies. Duck nests (n = 3,700) were systematically discovered within a subset of the thirty-five grazed pastures. Preliminary results showed no difference in duck nest success among the three grazing strategies. However, results suggest that differences in nest success and nest densities may occur on pastures within a given rotational grazing system. Results from this study may be utilized to help determine which grazing strategy could be most beneficial for duck production and also may be utilized to determine the amount of potential cattle production that is perhaps foregone for such duck production.

Effects of fencerow vegetation removal on grassland birds & their predators – Four year summary

Presenter: Kevin Ellison, Wildlife Conservation Society (kellison@wcs.org)

Other authors: C. A. Ribic, USGS Wisconsin Cooperative Wildlife Research Unit; D. W. Sample, Wisconsin Department of Natural Resources; M. E Jones, University of Wisconsin.

Obligate grassland birds are in serious decline and several aspects of habitat quality have been identified for improving their productivity. Many predators concentrate their activity along linear habitat features such as habitat edges. In the wooded-grassland matrix common in midwestern and eastern North America, typical woodland species will use wooded fencerows as travel corridors through grasslands between woodlots. During 2005-08, we conducted an ecological experiment to determine the benefits of tree row removal. We measured avian species abundance, habitat use, and productivity at control and removal sites. We also measured predator activity using tracking stations and identified predators using nest cameras. We expected that more birds would use the habitat adjacent to fence rows after the woody vegetation was removed, resulting in more nesting attempts and greater productivity. We also expected a shift in the predator community, with a decrease in the presence of species associated with woodland habitats. Despite ceasing nearly all use of grasslands by woodland species, nest success did not improve consistently across species or years following vegetation removal. Instead, predation by grassland species increased ($X2 = 20.2$, $P = 0.003$), in particular that by ground squirrels (*Spermophilus* spp.). However, because of increased avian densities within 100m of the fencerow (linear trend model; Bobolink: $F = 13.54$, $df = 1, 18$, $P = 0.002$; Henslow's Sparrow: $F = 5.19$, $df = 1, 18$, $P = 0.035$), more nests were attempted (nest density increased by factors of 2-4 depending on the species) and estimated productivity improved. Our results demonstrate that treerow removal can benefit grassland birds, yet the degree of benefit is affected by local predator assemblages and dynamics.

5

Energy Development and Grasslands

Haying at EcoSun Prairie Farm. Credit: Carter Johnson, South Dakota State University.

"New conservation strategies are needed to protect grassland wildlife habitat… Using new markets for biomass offers the tantalizing prospect of maximizing the amount of perennial grassland, land that could benefit wildlife, provide income to farmers, and contribute to domestic renewable energy production."

– Fargione, J.E., et al. 2009. Bioenergy and Wildlife: Threats and opportunities for grassland conservation. *Bioscience* **59(9)**, 767-777.

Biomass Production of Selected Perennial Herbaceous Warm-season and Cool-season Grasses, and Legumes in Central and Western North Dakota for Bioenergy

Presenter: Paul Nyren, North Dakota State University (P.Nyren@ndsu.edu)

Other Authors: Guojie Wang, Bob D. Patton, and Anne Nyren, Eric Eriksmoen, Gordon Bradbury, Mark Halverson, and Ezra Aberle, North Dakota State University; Qingwu Xue, Texas A&M University; Kris Nichols and Mark Liebig, USDA ARS.

The state of North Dakota has a great potential to produce perennial herbaceous biomass for bioenergy purposes due to its large area of Conservation Reserve Program (CRP) and erodible, saline, and marginal croplands. Switchgrass *(Panicum virgatum)* has been identified as a "model" bioenergy crop by the Department of Energy (DOE) of the USA. Biomass production of switchgrass as well as other promising species such as intermediate wheatgrass *(Thinopyrum intermedium),* tall wheatgrass (Thinopyrum ponticum), big bluestem *(Andropogon gerardii)* were investigated at Carrington, Hettinger, Minot, Streeter, and Williston across central and western North Dakota from 2006 to 2011. At Williston, a paired irrigation site was used to compare the effect of irrigation on species biomass production. The field study plots harvested annually or biennially to investigate the harvest frequency effects on species production.

The establishment of cool-season grasses such as intermediate wheatgrass and tall wheatgrass was appreciable for all study sites; however, the establishment of warm-season grasses such as switchgrass and big bluestem was problematic at Hettinger and Williston without irrigation land. In comparison, at Williston with irrigation land warm-season grasses were soundly established under same cultural management as Williston dry land. Therefore, the establishment of warm-season grasses in these dry areas was mainly driven and constrained by available soil water in the growing season. Furthermore, intermediate wheatgrass and tall wheatgrass are the alternatives for the biomass production in these dry areas only from the establishment perspective. At Streeter and Minot, weed control was crucial to establish warm-season grasses, otherwise more years need to be put aside to let the warm-season build themselves and outcompete with common weeds. Glyphosate could be used to control early growing weed species in spring before the warm-season grasses start to grow, however, the application rate and time window need to be further tested. At Carrington, the establishment of warm-season grasses was promising, with mechanical mowing in the establishment year being helpful as well as with the appropriate ecological and climatically conditions. The seeding methods (timing, rate, depth, seedbed preparation et al.) at all study sites were the exactly same, site-specific seeding strategy should be investigated if establishment of warm-season grasses is the goal.

For annual harvest, study site accounted for 63% of the total data set variance and was a main factor for biomass production. While with irrigation at Williston, the production (9.61 Mg/ha) was the highest, following by wettest study site Carrington (9.23 Mg/ha), then Minot (6.70 Mg/ha) and Streeter (5.38 Mg/ha), the lowest at Williston without irrigation land (2.34 Mg/ha). The study site biomass production and its long-term mean annual precipitation were in the same order. However, the highest productive species or their combinations varied at each study site. Sunburst switchgrass produced the highest consistently from 2007 to 2011 at Williston irrigated land and Carrington with average production of 13.35 Mg/ha and 10.60 Mg/ha, respectively. Any combination with Sunburst switchgrass did not increase biomass production significantly at these two sites. At Williston non-irrigated dry land, haymaker intermediate wheatgrass was consistently the highest from 2007 to 2011 with an average production of 3 Mg/ha. The results at Minot and Streeter were mixed and complex. At Minot, alkar tall wheatgrass and mixtures with it (9-10 Mg/ha) were the highest from 2007 to 2008 while in 2009, they were still the highest but all the entries were statistically same. From 2010 to 2011, Dakota switchgrass, Sunburst switchgrass, and sunnyview big bluestem were the highest. As a result, five years average was not significantly different for all the entries, however, Sunburst switchgrass + Alkar tall wheatgrass combination (8.09 Mg/ha) was the highest numerically, due to contributions from two components with peaks at different years. At Streeter, the similar trend as at Minot was found, namely, from 2007 to 2009, cool-season grasses produced the highest, cool-season and warm-season grasses were similar in 2010, while in 2011, Sunburst switchgrass produced the highest (9.73 Mg/ha). Five years average of Alkar tall wheatgrass + Sunburst switchgrass combination (6.70 Mg/ha) was the highest.

For biennial harvest, similar results were found as annual harvest, i.e. study site with higher annual harvest production was also had higher biennial harvest production; species with higher annual harvest production at each study site normally had higher biennial harvest production in that corresponding study site. However, at Williston non-irrigated land biennial harvest of Sunburst switchgrass or its combination with Mustang altai wildrye was the highest (2.24 Mg per ha per year) while annual harvest of Haymaker intermediate wheatgrass was the highest. Overall, biennial harvest biomass production could only account for 63% total biomass from two-year annual harvest. However, accountability varied with study sites, with Williston dry land (76%) the highest, following by Minot (71%), Williston irrigated land and Streeter (66%), and the least at Carrington (56%).

At least in central North Dakota, Sunburst switchgrass establishes and produces soundly, however, in western North Dakota the switchgrass establishment is problematic and intermediate wheatgrass is an alternative for the dry areas for biomass production. Weed control is crucial at Streeter and Minot, the combination of switchgrass and wheatgrass in these areas could stabilize first three years production. In the dry area, biennial harvest could be an option since their high accountability. Irrigation improved stand establishment and had profound effect on biomass production while its economical and environmental feasibility needs further study.

Sustainable Harvest Strategies for Biofuels and Wildlife Production

Presenter: Susan P. Rupp, South Dakota State University (susan.rupp@sdstate.edu)

Introduction

The Prairie Pothole Region (PPR) of the upper Midwest has emerged as the largest source of ethanol production in the country (NRC 2010). Additionally, this region is critical for waterfowl recruitment, producing 50–80% of the continent's duck populations (Cowardin et al. 1983, Batt et al. 1989, Reynolds 2005) and providing breeding habitat for more than half of the total number of grassland bird species breeding in North America (Knopf 1996). Native perennial grasses of the PPR are prime candidates for cellulosic ethanol production because of their high biomass production, tolerance to climatic conditions, and compatibility with conventional farming practices (Rinehart 2006, Fargione et al. 2009). However, these grasses provide several benefits to fish and wildlife species.

If wildlife resources are to be protected in conjunction with large-scale conversion of lands to biofuels production, it is imperative to determine planting and harvest techniques consistent with fish, wildlife, habitat, soil, nutrient management, and water conservation goals (Bies 2006). The objectives of this study were to: 1) Determine which stubble height and season of harvest is most beneficial for maximizing biomass production/quality in mixed-grass native grasslands, 2) Determine which stubble height is most beneficial for maximizing nesting success/diversity of economically important bird species as well as migratory grassland songbirds in eastern South Dakota, and 3) Provide an analysis of the economic trade-offs associated with various combinations of biomass and wildlife production based on results obtained.

Materials and Methods

Using a randomized block design approach, a series of study sites roughly ~16.2 hectares in size were established across southeastern South Dakota. Plots were harvested at either 10 centimeters (4 inches) or 30 centimeters (12 inches) in the fall of 2009 and 2010 to determine the response of various birds species (pheasants, waterfowl, and songbirds) when compared to a no-harvest control.

Sites were located on state Game Production Areas (GPAs), federal Waterfowl Production Areas (WPAs), or private land. All sites selected were previously farmed and planted within the last 15 years to a 7 to 10 species native grass mixture with ≥50% of the plot consisting of native, warm-season grass. Historic management included burning, haying, grazing, spraying, and seed harvesting. With the exception of spot spraying for noxious weeds, all management activities were halted during the duration of the project.

In the summer of 2010 and 2011 (following haying treatments the previous fall), sites were surveyed 4 times per year to determine nesting success and diversity of birds. Standard nest dragging techniques were used for ducks and pheasants. Species and number of eggs were recorded for all nests found and incubation stage was determined by candling duck eggs and floating pheasant eggs. Songbirds were sampled using standard spot-mapping techniques.

Vegetative cover and composition were recorded along a series of three, 100-m transects in each field. For grassland songbirds, an additional 30 vegetative survey points were systematically placed along avian survey transects at set intervals to evaluate vegetative structure For biofuel quality and yield, 30 1/16-m^2 quadrats were clipped within each field, but adjacent to haying treatments, in both the fall and spring for chemical analysis to determine potential theoretical ethanol yield as it relates to seasonal changes.

Daily survival for ducks and pheasants was analyzed using Program MARK. The effect of haying treatment on total abundance of game birds and songbirds, as well as seasonal effects on biochemical composition, was analyzed using a mixed model analysis of variance in SAS (version 9.2) where block was designated as the random effect and haying treatment was the fixed effect. Because diversity indices often do not follow assumptions of normality, nest diversity (ducks and pheasants) and songbird diversity were analyzed using non-parametric procedures in program PERMANOVA, developed by Marti Anderson (Department of Statistics, University of Auckland, New Zealand) and Ray Gorley and Bob Clarke (PRIMER-E Ltd, Plymouth, UK).

Preliminary Results

As of fall 2011, only a single year of bird data were analyzed. Analysis of variance one-year post-treatment indicated a significant difference ($P = 0.0143$) in duck nests per hectare between the 10-cm and 30-cm cuts with fewer nests in the high intensity harvest, but no difference between 30-cm cuts and the non-harvest control (Table 3). Simpson's diversity (P = 0.0063) and richness (P = 0.0060) of duck nests per hectare showed similar results with significant differences between the 10-cm and 30-cm cuts, but no difference between the 30-cm cuts and no-harvest controls (Table 3). Though no significant difference ($F_{2,33}$ = 3.285; P = 0.229) was found among haying treatments for pheasants, non-harvested controls contained more birds than either the 10-cm or 30-cm treatments when results were pooled across years (Figure 7).

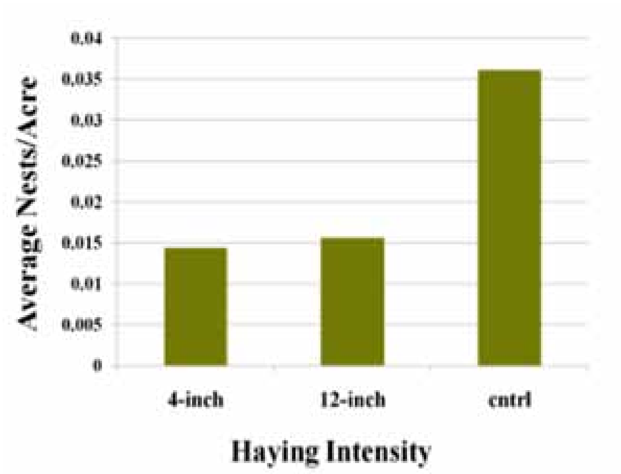


Figure 7. Effect of haying treatments on total density of pheasants for plots in southeastern South Dakota during the summer of 2010 and 2011. No significant difference (F2,33 = 3.285; P = 0.229) was found when results were pooled across years.

No significant differences were found among haying treatments for four focal species of migratory grassland songbirds: savannah sparrow *(Passerculus sandwichensi),* grasshopper sparrow *(Ammodramus savannarum),* dickcissel *(Spiza americana)*, or bobolink *(Dolichonyx oryzivorus).* However, vegetation structure strongly influences the occurrence of these species and may be affected by the haying treatments applied (Figure 8). Harvesting perennial grasses for biofuels in the late fall appears to change the vegetation structure and songbird species composition on the prairie the following year (Maves 2011).

Biomass harvesting on grasslands significantly reduces visual obstruction, vegetation height, litter depth, and percent coverage of litter for the next growing season.

Twice as many bales were harvested on 10-cm plots (= 164.65 ± 20.89) when compared to 30-cm plots (= 80.07 ± 20.80). As a result, total biomass yield (tons/acre) was almost twice as much on a 10-cm stubble height (= 2.0437 ± 0.2908) compared to the 30-cm stubble height (= 1.1033 ± 0.2908). Though theoretical ethanol yield differed from year 1 to year 2, there was no difference (P = 0.7011) between plots harvested in fall versus spring when results were pooled across years. Additional analyses to determine the effect of vegetative composition (e.g., warm- versus cool-season grasses) on ethanol yield are in progress.

Table 3. Average densities (nests/hectare), species richness (number/hectare), and species diversity (Simpson's index) and treatment P-values for of game birds on high (10-cm) and low intensity (30-cm) harvests as well as no-harvest control sites in 2010 in southeastern South Dakota. Lower case letters that are the same within a given row indicate no significant difference among specific treatments. Means were estimated at an average vegetation species richness of 12.2 due to correlative effects on bird parameters.

Response Variable	Control		10-cm Stubble		30-cm Stubble		P-value
Nests/Hectare (All Game Birds)	0.48^{b}		0.18^{a}		0.62^{b}		0.0191
Nests/Hectare (Ducks Only)	0.27^{b}		0.12^{a}		0.31^{b}		0.0143
Nest Richness (#/Hectare)	4.24^{b}		2.01^{a}		3.99^{b}		0.0060
Nest Diversity (Simpson's)	1.14^{b}		0.53^{a}		1.10^{b}		0.0063

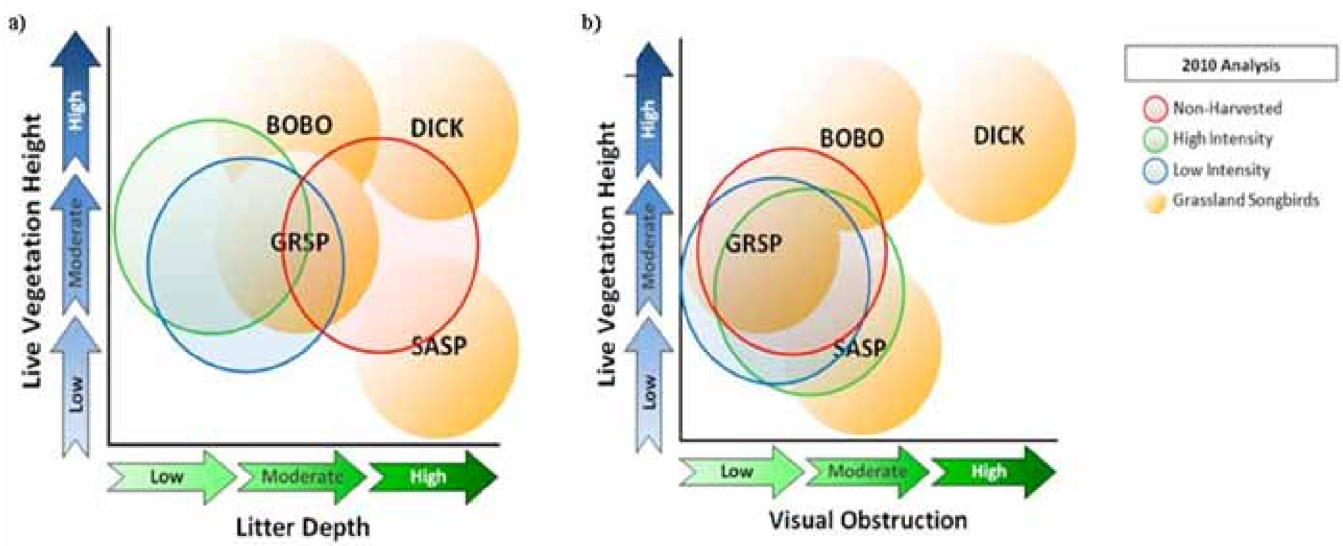


Figure 8. Conceptual diagrams showing: a) the theoretical litter depth and live vegetation height, and b) the theoretical visual obstruction and live vegetation height used by the savannah sparrow (SASP), grasshopper sparrow (GRSP), dickcissel (DICK), and bobolink in gold bubbles. The songbird habitat requirements are overlain by a larger bubble (in color) illustrating the actual visual obstruction, litter depth, and live vegetation height results from the 10-cm (high intensity), 30-cm (low intensity), and non-harvested sites in southeastern, South Dakota, USA, in 2010 (Adapted from Maves 2011).

Discussion

The frequency, intensity, and timing of harvest may be the most important factors to consider from both a wildlife and biofuels standpoint (Bies 2006, Schmer et al. 2008). Seasonal timing of harvest can affect biomass yield and biofuel quality for energy production in fermentation, gasification, or direct combustion systems (Adler et al. 2006, Lee et al. 2007). Though harvesting of biomass in the fall or winter may not have direct effects on grassland birds, species composition, abundance, diversity, and nest success may be affected by changes in vegetation structure due to harvesting (Murray and Best 2003). However, spring harvest of such crops may provide essential wildlife cover during the winter months while simultaneously increasing biofuel quality (Murray and Best 2003, Adler et al. 2006).

Harvesting perennial grasses for biofuels in the late fall appears to change the vegetation structure and songbird species composition on the prairie the following year, though individual species of songbirds responded differently depending on the life history characteristics (Maves 2011). Therefore, a mixture of harvested and non-harvested fields is recommended for the greatest benefit to grassland birds. However, higher total biomass yields at lower stubble heights imply producers will want to harvest closer to the ground for maximum economic benefit. Harvest of biofuel crops in southeastern South Dakota will likely occur after the first hard frost in the fall given there was no significant difference in theoretical ethanol yield between fall and spring and weather is more volatile in the spring making haying difficult at that time of year. It is also important to note that waterfowl abundance and richness were correlated with vegetation species richness, which may be affected by repeated harvests through time. This could have negative consequences on game birds based on preliminary results – especially pheasants given the patterns of response initially observed. Though the effects of haying treatment were not significant, both the spring of 2010 and 2011 experienced above normal amounts of precipitation, which is believed to have reduced total pheasant numbers for those years making our analysis less robust due to smaller sample sizes. We believe an increased sample size or additional years of data collection would result in statistically significant results.

Acknowledgements

Funding was provided by the National Fish and Wildlife Foundation, South Dakota Game, Fish, and Parks, the U.S. Fish and Wildlife Service, the North Central Sun Grant Center, and the Agricultural Experiment Station at South Dakota State University. Special thanks goes to my graduate students on the project – John Bender, Alisha Maves, and Alex Solem – as well as their many technicians. Dr. David Wester at Texas A & M – Kingsville assisted with data analysis. Other partners have included the University of Minnesota, EcoSun Prairie Farms, and, of course, our many, many haying cooperators!

References

Adler, P. R., M. A. Sanderson, A. A. Boateng, P. J. Weimer, and H. G. Jung. (2006) Biomass yield and biofuel quality of switchgrass harvested in fall or spring. *Agronomy Journal* **98**:1518-1525.

Batt, B. D. J., M. G. Anderson, C. D. Anderson, and F. D. Caswell. (1989) The use of prairie potholes by North American ducks. Pages 204-227 in A. G. van der Valk, editor. Northern Prairie Wetlands. Iowa State University, Ames, Iowa.

Bies, L. (2006) The biofuels explosion: Is green energy good for wildlife? *The Wildlife Society Bulletin* **34(4):**1203-1205.

Cowardin, L. M., A. B. Sargeant, and H. F. Duebbert. (1983) Problems and potentials for prairie ducks. *Naturalist* **34,** 4–11.

Fargione et al. (2009) Bioenergy and Wildlife: Threats and Opportunities for Grassland Conservation. *Bioscience* **59(9),** 767-777.

Knopf, F. L. (1996) Prairie legacies: birds. Pages 135-149 in Prairie Conservation: Preserving North America's Most Endangered Ecosystem. Fred B. Samson, Fritz L. Knopf, editors. Island Press, Washington, D. C. USA. 339 pp.

Lee, D. K., V. N. Owens, and J. J. Doolittle. (2007) Switchgrass and soil carbon sequestration response to ammonium nitrate, manure, and harvest frequency on Conservation Reserve Program land. *Agronomy Journal* **99,** 462-468.

Maves, A. J. (2011) Developing sustainable harvest strategies for cellulose-based biofuels: The effect of intensity of harvest on migratory grassland songbirds. M.S. Thesis, South Dakota State University, July 2011. 104 pp.

Murray, L. D., and L. B. Best. (2003) Short-term bird response to harvesting switchgrass for biomass in Iowa. *Journal of Wildlife Management* **67**, 611-621.

Reynolds, R. R. (2005) The conservation reserve program and duck production in the U.S. prairie pothole region. Pages 33-40 in Haufler, J. B., editor. 2005. Fish and wildlife benefits of Farm Bill conservation programs: 2000-2005 update. The Wildlife Society Technical Review 05-2.

Rinehart, L. (2006) Switchgrass as a bioenergy crop. ATTRA – National Sustainable Agriculture Information Service (www.attra.ncat.org). 12 pp.

Schmer, M. R., K. P. Vogel, R. B. Mitchell, and R. K. Perrin. (2008) Net energy of cellulosic ethanol from switchgrass. Proceedings of the National Academy of Sciences of the United States of America **105**, 464-469.

South Dakota's Prairie Farm: An experiment in ecologic and economic sustainability

Presenter: Carter Johnson, South Dakota State University (carter.johnson@sdstate.edu)

The pluses and minuses of bioenergy development in terms of climate protection, energy security, and rural economic development will depend substantially on the nature of the farming system that produces the biofuel feedstock materials. The current system that produces corn grain as feedstock for the ethanol industry has been shown to use about as much energy in production (e.g., fossil fuel for field work, fertilizer, biocides, and transportation; bioprocessing; etc.) as is gained from the fuel. Moreover, row crop farming of corn appears to be unsustainable on many Corn Belt soils because of erosion, declining soil quality (including loss of carbon), and fencerow-to-fencerow farming that destroys natural ecosystems and their free benefits to society, especially wildlife and water quality.

An alternate farming approach to produce biofuel feedstock material and other products on a sustainable basis with low input costs while improving all measures of the environment on row-cropped farmland has been under investigation since 2007 by EcoSun Prairie Farms, Inc., a non-profit South Dakota corporation. EcoSun leases a 650-acre working farm (the "Prairie Farm") located near Brookings, SD and has converted fields of row crops formerly under corn and soybean rotation to various types of restored grassland, the natural vegetation of the region. The goal of the project is

Bluestem mixture in second year after planting, EcoSun Prairie Farm. Credit: Carter Johnson.

Prairie cordgrass (left) and big bluestem (right) plantings at the EcoSun Prairie Farm. Credit: Carter Johnson.

to demonstrate how to make a sustained and earned living from the restored grassland while protecting and enhancing the environment. A wide range of grassland types has been planted on the 400 acres of former cropland, including switch grass monocultures (3 ecotypes/varieties); both low and high species diversity species mixtures dominated by big bluestem, including forbs; prairie cordgrass communities in 30 restored wetland basins and on other sub-irrigated ground; a 100 acre planting with a mixture of cool and warm season native grasses (35 species); and a very high species diversity (>100 species) planting (55 acres) using seed from a nearby virgin prairie remnant (Sioux Prairie owned by The Nature Conservancy).

Biomass production data for these plant communities across this environmentally-heterogeneous farm landscape will be available to this project as will be data on the environmental improvements associated with grass farming. Farm-scale feedstock production will provide more accurate yield and cost data (compared to small, environmentally-uniform plot studies), as well as on-the-ground data to monetize ecosystem goods/services. Water quality and volume entering the farm through 2 streams and leaving through one stream are being monitored. Baseline soil quality data (emphasizing soil carbon fractions) have also been collected across the farm and with depth. A baseline avifauna survey was completed in 2010. Insect (pollinator) surveys across the farm are expected to begin in 2012. In short, considerable data are available to estimate the economic value of the grass crops produced and marketed along with estimates of the ecosystem goods and services provided by the restored grassland ecosystem. These estimates will be based on actual yield, cost, and competing market data that will be more accurate than estimates made from research plots.

EcoSun has tested the various markets available for the products produced on a grass-based farm that can stabilize income for a family. These include hay, native plant seed from upland and wetland plants, and grass-fed beef. Additional income streams in the future are likely to be carbon credits, ecotourism/summer educational courses, and biofuel feedstocks.

Almost no commercial grassland comprised of native species remains in the tall grass prairie region of central North America to provide biofuel feedstocks. To reverse this trend, restored native, perennial grassland could replace annual corn on productive agricultural land to produce biofuels more efficiently along with providing valuable ecosystem goods and services (e.g., wetlands, wildlife, climate protection). Also, marginal farmland that is often too wet for upland row crops could be planted with perennial grass crops, such as prairie cordgrass, to produce income from hay, seed, and in the future, biofuel feedstock. Converting these lands to economically-viable mixtures of perennial grassland species that under proper management will be productive for decades with low input is a prescription for sustainability compared to the current tillage and Conservation Reserve Program system.

Development of Best Management Practices Documents for Wind Energy Development on Colorado's Eastern Plains

Presenter: Anne Bartuszevige, Playa Lakes Joint Venture (anne.bartuszevige@pljv.org)

Other authors: Mike Carter, Playa Lakes Joint Venture; William Burnidge, The Nature Conservancy

Wind energy development is a growing industry that is a 'green' alternative to oil and gas development. However, species may be at risk through direct (collision mortality) and indirect (avoidance distances) impacts. As a result, government and non-profit wildlife agencies are developing written guidelines for responsible siting of wind energy developments. Many of these documents are static and rarely provide the sort of guidance needed for mitigating effects of wind energy developments. The eastern plains of Colorado have been identified as a high wind resource region. To address the conservation issues surrounding increased wind development in Colorado grasslands, the Colorado Renewables Resource Collaborative (CRCC) was formed. The CRCC was formed by science-based non-profit wildlife organizations and wind energy developers to create responsible siting guidelines that were "conservation credible and business viable". In this presentation, I will briefly discuss the process for bringing these groups together and discuss in detail one result of this working group; the written best management practices documents. The CRCC wrote and approved documents for 12 different resources that have a known or predicted interaction with wind developments for example, raptors, migratory passerines and Lesser Prairie-Chicken. Documents are short, describe the interaction with wind energy development, and focus on avoid, minimize and mitigate options for conservation. Scientific credibility was an important criterion for the CRCC, therefore all documents were sent out for scientific review. These documents are intended to be a conversation starter between wildlife agencies and wind industry for conservation related to specific projects. This is evident by the focus on conservation actions in the best management practices documents. Colorado Division of Wildlife has agreed to use these documents as their standard for working with wind energy projects and the CRCC is referenced in the public utility commission regulations. This process has been exported to other states in the southern Great Plains. The development of best management practices documents highlighted the need for solid management recommendations based on hypothesis-driven research and knowledge gaps that currently exist for informing conservation decisions.

Effects of shallow-gas development on densities and diversity of grassland songbirds

Presenter: Jennifer Rodgers, University of Manitoba (umrodger@cc.umanitoba.ca)

Co-author: Nicola Koper, University of Manitoba

The natural gas industry requires the use of shallow-gas wells, pipelines, access roads, and other related infrastructure, for resource extraction. Such anthropogenic disturbances can have widespread impacts on wildlife. Grassland habitats are in decline due to habitat loss and under-protection, which has led to a greater loss of grassland bird species in these regions than in any other group of birds found in North America. Between 1966 and 1993, more than 50 percent of grassland bird species in midland North America experienced significant declines (Herkert 1995). The Sprague's pipit (Anthus spragueii), one of the grassland birds included in this study, experienced population declines of greater than 78 percent between the years 1967 and 2007 (Sauer et al. 2008).

This study seeks to identify the effects of shallow-gas well infrastructure on the densities and diversity of grassland songbirds in south-eastern Alberta, Canada. These disturbances create habitat edges, which may either positively or negatively influence the densities and diversities of grassland songbirds. One potential environmental effect of anthropogenic disturbance is the creation of habitat edges, which may either positively or negatively influence the densities and diversities of grassland songbirds (Davis et al. 2006; Koper et al. 2007; Koper et al. 2009). Edges may contribute to an increase or a decrease in predation and vegetation structure may be altered, which may benefit some bird species but negatively affect others (Linnen 2006; Koper et al. 2009). Linear features associated with the natural gas industry, such as roads, may also allow for the introduction of non-native species.

There are many possible impacts of natural gas development on grassland songbirds, but an actual understanding of these impacts is limited. As development continues at a rapid rate, and densities of infrastructure increase, it is important to study cumulative impacts. The objectives of this research are to discover any impacts on grassland songbird species, and if a negative impact is found, to identify a maximum threshold of development.

This study was conducted in south-eastern Alberta, Canada within the counties of Newell, Vulcan, Taber and Cypress. Forty sites were surveyed in 2010 for diversity and relative abundance of grassland songbirds, with 10 point-count plots per site. Mixed-grass prairie vegetation was predominant on all sites. The relative abundance of infrastructure and well heads ranged from 0 to 29 well heads/1 x 1 mile section. The relative abundance of songbirds was measured using 6-minute point-counts with a 100m fixed-radius plot size. Centres of point-count plots ranged from 50 m to approximately 2000 m from infrastructure, to allow for modelling of distance to edge on diversity and relative abundance of birds. This multi-scale approach is key, as factors influencing bird species vary at different spatial scales, and local avoidance may or may not have a broader-level influence on populations. Vegetation sampling was also conducted using quadrats and transect vegetation surveys. Many grassland bird species are selective in their habitat use based on vegetation density. Because of reseeding and mowing surrounding pipelines and well sites, the impact of the natural gas industry on vegetation density may in turn impact grassland songbird species.

Preliminary results did not show a statistically significant relationship between well density and species richness. Further, well density was not found to statistically significantly influence any of the species of interest in the study, such as the Sprague's Pipit, Chestnut-collared Longspur *(Calcarius ornatus),* Savannah Sparrow *(Passerculus sandwichensis),* Baird's Sparrow *(Ammodramus bairdii),* and Western Meadowlark *(Sturnella neglecta).* We found no statistically significant relationship between vegetation density and species richness.

Though to date this study has not found any statistically significant relationships, data from 2011 must still be analyzed in combination with the 2010 data. This larger sample size may affect our conclusions. As well, we predicted that distance to well may have a local-scale influence on habitat suitability. Distance to well analysis is still not complete. This means that more research into the possible impacts of the natural gas industry on grassland songbirds is still required.

References

Davis, S. K., R. M. Brigham, T. L. Shaffer, and P. C. James. (2006) Mixed-grass prairie passerines exhibit weak and variable responses to patch size. *The Auk* **123**, 807-821.

Herkert, J. R. (1995) An analysis of midwestern breeding bird population trends: 1966-1993. *American Midland Naturalist* **134**, 42-50.

Koper, N., F. K. A. Schmiegelow, and E. H. Merrill. (2007) Residuals cannot distinguish between ecological effects of habitat amount and fragmentation: implications for the debate. Landscape Ecology **22**:811-820.

Koper, N., D. J. Walker, and J. Champagne. (2009) Nonlinear effects of distance to habitat edge on Sprague's pipits in southern Alberta, Canada. Landscape Ecology **24**:1287-1297.

Linnen, C. (2006). The effects of minimal disturbance shallow gas activity on grassland birds. Northern EnviroSearch, Saskatoon, Saskatchewan, Canada.

Sauer, J. R., J. E. Hines, and J. Fallon. (2008) The North American breeding bird survey, results and analysis 1966 - 2007. Version 5.15.2008.United States Geological Survey Patuxent Wildlife Research Center, Laurel, Maryland, USA.

The Role of Federal Policy in Grassland Conversion

6

Economics of Grassland Conversion

Presenter: David Archer, USDA Agricultural Research Service, Northern Great Plains Research Laboratory (david.archer@ars.usda.gov)

From 1997 to 2007, there were net increases in all categories of grasslands in the U.S., including the Conservation Reserve Program (CRP), rangeland, pasture, and hay lands (Claassen et al., 2011). However, there have been regional differences in grassland conversion trends. In the Northern Great Plains (NGP), CRP and pasture increased, while rangeland and hay land acres decreased over this period. There have likely been further changes since 2007. In North Dakota, CRP area declined from 2007 to 2010 to the lowest levels since 1989 (USDA-FSA). In this paper we provide an overview of economic factors that contribute to these changes, including the relative profitability of crop and livestock production, effects of land productivity, and effects of conversion costs. We identify other potential socio-economic influences on grassland conversion, and describe a case farm where the use of multiple enterprises is being investigated as a method to improve economic returns from grasslands and reverse the trend toward conversion of grasslands to cropland.

From an economic perspective, land use decisions are influenced primarily by the relative profitability of alternative land uses. In the NGP, profitability of wheat production has generally increased since 1997 and especially since 2002 (USDA-ERS, 2011). This increase reflects rapid rises in wheat prices, but increases in profitability have been moderated by increased production costs over this same period (USDA-ERS, 2011). These trends have also occurred for other crops in the region. Along with increases in crop profitability have been increases in land rent. This presents

Conversion of native grassland to cropland in the northern Great Plains. Credit: Chuck Pyle, U.S. Fish and Wildlife Service.

"Trouble is on the horizon for grasslands, wetlands, and ducks. There is a rapidly growing world demand for food and commodities, production of corn ethanol has rapidly expanded, and the 2008 Federal Farm Bill provided incentives to convert grassland to cropland. Grassland destruction is accelerating."

–Warhurst, R. Grasslands for Tomorrow- A model for protecting the prairie and wetland ecosystem (page 54).

challenges for maintaining enrollment in programs with fixed annual payments such as CRP. A typical CRP contract is for 10 years, with annual payments fixed for the entire life of the contract and based on cropland rents at the time enrollment occurred. When cropland cash rent is relatively stable producers are willing to enroll and remain in the program since cash rent at the end of the contract is not substantially higher than when the contract began. For example in Burleigh County, North Dakota, from 1989 to 1998 (USDA-NASS, 2011), cash rent at the end of the 10 year contract was only 22% greater than at the beginning of the contract with most of the increase occurring only in the final 3 years. However, for a producer with a contract beginning in 1999, cash rent in the county had increased 32% by the end of the contract, and for a contract beginning in 2001, cash rent had increased 44% by 2010 (Figure 9). Since CRP had become much less profitable than renting the land out as cropland, many producers chose not to reenroll.

For range and pasture lands in the NGP, income from cattle production is the primary alternative to crop production. In the NGP, cow-calf net returns have shown cyclical increases and decreases. Gross returns have shown an upward trend, but declined from 2005-2009, likely related to reduced beef demand as a result of recession and increased feeding costs at feedlot. At the same time, cow-calf production costs have shown an upward trend, closely tied to feed costs. As a result, profitability also declined over that period (USDA-ERS, 2011). Beef cattle numbers have declined with the lower profitability, which has tended to reduce both grazing/forage needs and the value of grasslands. This has been somewhat mitigated since the price of feed grains has increased, tending to increase demand for grass/forage. Many factors have contributed to rising crop prices over the period, including increasing energy prices, rising food and feed demand, use of corn for biofuels, and a long period of declining stocks relative to use (USDA-ERS, 2011).

A common conceptual model is that grasslands tend to be more profitable on soils that have lower productivity and crops tend to be more profitable on soils that have higher productivity (Claassen et al., 2011). This is supported by the observation in the NGP that most high productivity land is in cropland, while most low productivity land is in rangeland. However, proportions in CRP, hay, or pasture show no strong relationship to land productivity (Claassen et al., 2011). It is not clear if this is truly due to differences in productivity, or if productivity classes are often related to other factors that limit the feasibility of cropping (e.g. high slope, rocky, wet), and grazing is just physically more practical. Based on the conceptual model, increasing crop prices with all else held constant shifts the breakeven point between cropland and grassland, with more marginal lands becoming profitable for crop production.

However, converting between crop and grass uses is costly. In an ongoing study at Mandan, ND (Hendrickson, J. and Tanaka, D., unpublished data) the direct cost of transitioning from grass to crop was relatively low, as little as the cost of a single herbicide application. There is some evidence that there could be additional costs associated with crop yield reduction following conversion. Also, cost of conversion from grass to crop can be greater if there is a need to remove excess vegetation, use tillage to smooth the land, or use labor and equipment for removing rocks. Costs for conversion from crop to grass can be substantial, including seed and seeding costs, forgone income while waiting for grass to establish, and the risk of reseeding if establishment fails. In the Mandan study, cumulative costs were estimated at $207 per acre for conversion of cropland to switchgrass relative to continuous crop production. Presence of conversion costs can serve as a barrier to conversion in either direction, so producers want to be sure that they will stay with the new land use for a long enough period of time to recoup the conversion costs. Reducing conversion costs (e.g. cost-sharing establishment of grass) reduces this barrier to conversion in either direction, which could have the counterintuitive impact of accelerating the conversion from grass to crop since it will be less costly to convert back to grass in the future.

Other socio-economic factors can also influence land use decisions. Some of these factors include off-farm employment, lifestyle goals, and demographics. Greater off-farm work, preferences to live in a rural area, and older producers have been associated with a greater percentage of farm production value from beef and lower percentage from crops (Gillespie and Mishra, 2011), and thus are likely to lead to more grassland and less cropland. College graduates, however, likely realize greater percentages of farm production value from crops and lower percentages from beef (Gillespie and Mishra, 2011).

From a simple profit-maximizing point of view, the temptation is to select the single enterprise that generates the greatest return. However, this ignores potential synergies among enterprises, spreading time and risk across multiple enterprises, and the potential for generating multiple income streams from the same piece of land, including income generated from the production of ecosystem services (other than the typical provisioning services of food and feed production). The approach being taken on the EcoSun Prairie Farm is to look at the potential for multiple enterprises to increase profitability of grasslands. These enterprises include cellulosic biofuel feedstocks, hay production, carbon credits, cattle, seed, and recreation (tourism and/or hunting). The idea is that grasslands might be economically viable if producers are able to capture more of the value of the ecosystem service they provide. Farm economic performance will be evaluated in comparison to crop farms in the area to determine if grasslands can be economically competitive with crop production on highly productive land. If so, this might reduce or reverse the recent trend toward conversion of grasslands to crop production.

Trends in grassland conversion are heavily influenced by economics, and an important driver of future grassland conversion will be determined by whether the current trend toward increasing crop profitability will continue. A wildcard is the goals for expanded biofuel production, and how this might affect the relative profitability of crop and grasslands.

Other important factors include the degree to which the value of ecosystem services generated on grasslands can be captured at the farm level, and the influence of changing lifestyle and demographic factors.

References

Claassen, R., Carriazo, F., Cooper, J. C., Hellerstein, D. & Ueda, K. (2011) Grassland to Cropland Conversion in the Northern Plains: The Role of Crop Insurance, Commodity, and Disaster Programs. pp. 85. U.S. Department of Agriculture, Economic Research Service, Washington, DC.

Gillespie, J. & Mishra, A. (2011) Off-farm employment and reasons for entering farming as determinants of production enterprise selection in US agriculture. *Australian Journal of Agricultural and Resource Economics,* **55**, 411-428.

USDA-ERS (2011) Commodity Costs and Returns: Data. U.S. Department of Agriculture, Economic Research Service, Washington, DC.

USDA-FSA (2011) CRP Enrollment and Rental Payments by State, 1986-2010. U.S. Department of Agriculture, Farm Service Agency, Washington, DC.

USDA-NASS (2011) North Dakota County Rents and Values. U.S. Department of Agriculture, National Agricultural Statistics Service, Washington, DC.

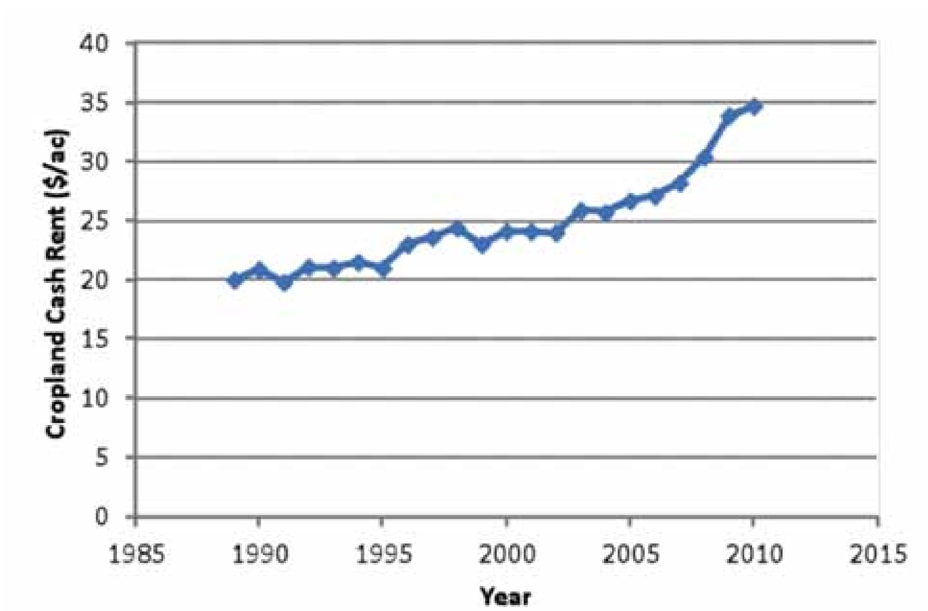


Figure 9. Average cropland cash rents, Burleigh County, North Dakota.

Cropland Expansion into Prairie Pothole Wetlands, 2001-2010

Presenter: Carol Johnston, South Dakota State University (carol.johnston@sdstate.edu)

With sharply increasing prices for corn, soybeans, and wheat during the last decade, the Prairie Pothole Region (PPR) of the eastern Dakotas is under substantial pressure for agricultural development. Development of cold- and drought-tolerant crop strains has reduced the risk from suboptimal climatic conditions, shifting U.S. corn and soybean expansion to the north and west (Reilly et al. 2003). Wet, sandy, or steep soils remain deterrents to cropping (Baker & Capel 2011), but increasing commodity prices have reduced the economic barriers to cropping these marginal lands (Rashford, Walker & Bastian 2011).

Grasslands in the PPR typically exist as small remnants embedded in a larger matrix of cropland. Many PPR grasslands are used for hay or grazing, land uses that can preserve native vegetation, promote wildlife habitat, and accommodate variation in flooding and high water tables. Converting these grasslands into croplands decreases the ecosystem services that they provide.

I sought to determine the rate of grassland conversion to cropland in the PPR of the eastern Dakotas using available land cover databases for 2001 and 2010: the National Land Cover Database (NLCD) (Homer et al. 2007) and the USDA Cropland Data Layer (CDL) (Johnson & Mueller 2010). The CDL has been prepared annually since 1997 for North Dakota and since 2006 for South Dakota. Both data sources are derived from satellite imagery, are well documented, and are subject to rigorous quality control. I examined patterns of grassland occurrence and loss within different ecoregions of the Dakotas (Bryce et al. 1998), and verified the land use classifications using National Agriculture Imagery Program (NAIP) images taken in 2003 (the earliest NAIP imagery available) and 2010.

How Much Grassland Was There in 2001?

Any land use trend requires a starting point, and I considered two possible sources of data to define 2001 grassland. I generated the first candidate grassland map by selecting "Grassland/herbaceous" (class 71) and "Pasture/hay" (class 81) from the 2001 NLCD (Fig. 10a), and the second candidate map by selecting "Fallow/idle cropland" and "Pasture/grass" classes from the North Dakota 2001 CDL (Fig. 10b). After comparison of the 2001 data layers with each other and with available aerial photos, I

Figure 10: Comparison of grassland mapped in the vicinity of Cathay, North Dakota, extracted from: (A) 2001 NLCD, (B) 2001 CDL, and (C) 2010 CDL. Note loss of grasslands along the southern border of the image between 2001 and 2010. Dark yellow = grassland, light yellow = fallow/idle cropland (CDL only), brown = cropland, pink = developed.

concluded that the NLCD provided a truer rendering of 2001 grassland. The "Fallow/idle cropland" class in the 2001 CDL encompassed some grasslands as well as fallow croplands that were not grasslands (Fig. 10b). None of the databases used distinguished between native and non-native grasslands, and some of the grassland areas were highly managed (e.g., for alfalfa hay).

The area of grassland mapped by the NLCD within the Dakota PPR was 28,650 square miles, 34.3% of the total area. Large, continuous blocks of grassland occurred on steep and stony lands of the Missouri Coteau and Prairie Coteau Escarpment (Figure 11), and on sandy soils of the Beach Ridges and Sand Deltas in North Dakota. Grasslands were uncommon in the highly cultivated Lake Agassiz Plain and Northern Black Prairie ecoregions of North Dakota, and the Glacial Lake Basin ecoregion in the northern James River Valley of South Dakota. Elsewhere, grasslands were interspersed among croplands in fragmented landscapes (Figures 10, 11).

How Much Grassland Was Converted to Cropland by 2010?

By 2010, cropland had replaced 16.9% (4,838 mi2) of the 2001 grassland. Three crops constituted the vast majority of this new cropland in about equal proportion: corn, soybeans, and wheat.

The pattern of loss in Roberts County, South Dakota and Richards County, North Dakota, along the state border, is representative of the changes observed (Figure 11). Substantial grassland area remained on the steep Prairie Coteau at the western edge of Roberts County, but flatter lands below the Prairie Coteau escarpment were more susceptible to conversion. For example, nearly 3 sections of land west of Interstate 29 in Richland County (T129N, R49W) were converted from grassland to corn and soybeans (Figure 11). Inspection of the NAIP imagery verified that this was grassland in 2003 and cropland in 2010.

Conclusions

Conversion of grassland to cropland is occurring at a rapid pace in the PPR of the Dakotas. Improved agricultural technologies are reducing cultivation constraints, and land area devoted to pasture and hayland is declining

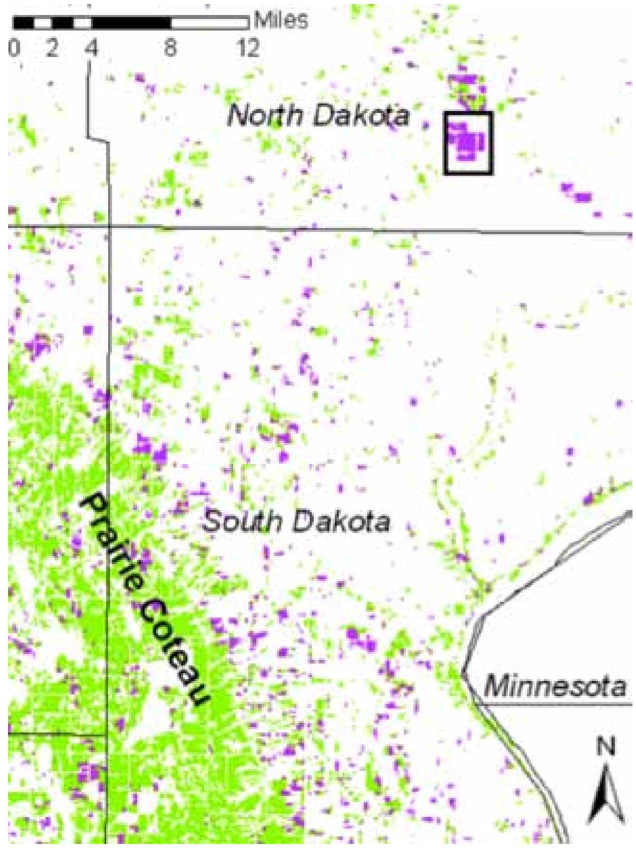


Figure 11: Grassland (green) and grassland-converted-to-cropland (purple) in southern Richland County, ND and Northern Roberts County, SD. black rectangle encloses A 1, 717 acre area converted from grassland to corn and soybeans.

as livestock operations are concentrated into feedlots or eliminated altogether. Some grassland conversion may also be due to the expiration of Conservation Reserve Program (CRP) contracts. In 2009, 2.8 million acres of CRP contracts expired nationwide, and that number increased to 4.5 million acres in 2010 (Thiesse 2010). Unfortunately, privacy concerns prevent distribution of detailed spatial data showing CRP lands. Regardless of the reason for grassland conversion, agricultural intensification will have serious ramifications for the future of this important natural resource.

References

Baker, N.T. & Capel, P.D. (2011) Environmental factors that influence the location of agriculture of crop agriculture in the conterminous United States. pp. 72. U.S. Geological Survey Scientific Investigations Report 2011–5108, Indianapolis, IN.

Bryce, S., Omernik, J.M., Pater, D.E., Ulmer, M., Schaar, J., Freeouf, J., Johnson, R., Kuck, P. & Azevedo, S.H.

(1998) Ecoregions of North Dakota and South Dakota. U.S. Geological Survey Northern Prairie Wildlife Research Center Online, Jamestown, ND. http://www.npwrc.usgs.gov/resource/habitat/ndsdeco/index.htm

Homer, C., Dewitz, J., Fry, J., Coan, M., Hossain, N., Larson, C., Herold, N., McKerrow, A., VanDriel, J.N. & Wickham, J. (2007) Completion of the 2001 National Land Cover Database for the Conterminous United States. *Photogrammetric Engineering & Remote Sensing,* **73**, 337-341.

Johnson, D.M. & Mueller, R. (2010) The 2009 Cropland Data Layer. *Photogrammetric Engineering and Remote Sensing,* **76,** 1201-1205.

Rashford, B.S., Walker, J.A. & Bastian, C.T. (2011) Economics of grassland conversion to cropland in the Prairie Pothole Region. *Conservation Biology,* **25**, 276-284.

Reilly, J., Tubiello, F., McCarl, B., Abler, D., Darwin, R., Fuglie, K., Hollinger, S., Izaurralde, C., Jagtap, S., Jones, J., Mearns, L., Ojima, D., Paul, E., Paustian, K., Riha, S., Rosenberg, N. & Rosenzweig, C. (2003) U.S. agriculture and climate change: new results. *Climatic Change,* **57**, 43-67.

Thiesse, K. (2010) What's Ahead for the CRP Program? *Corn & Soybean Digest.* http://cornandsoybeandigest.com/issues/what-s-ahead-crp-program

Land Use Consequences of Crop Insurance Subsidies

Presenter: David A. Hennessy, Iowa State University (hennessy@iastate.edu)

Other authors: Ruiqing Miao and Hongli Feng, Iowa State University

It is estimated that net conversion of Northern Great Plains rangeland was about 0.09% per year between 1997 and 2007, but the conversion rate in some counties just east of the Missouri River in the Dakotas may have been much higher, in the order of 0.6% per year (Claassen et al. 2011). It is important to recognize the technology and market environment surrounding these land use choices. The advent of herbicide-tolerant insect-resistant corn and soybean varieties since 1996 has reduced chemical, labor and management time costs associated with cropping while also likely increasing yields. In facilitating low-till cultivation, they may also have eased any conservation compliance constraints and reduced energy costs. In addition, seed companies have had success in introducing drought-tolerance into their product (Yu and Babcock 2010, Carena *et al.* 2009). Since 2006, historically high corn and other commodity prices have also incentivized conversion incentives, have driven up land rents, and have made the Conservation Reserve Program alternative less attractive. In the past three decades also, but especially since the mid-1990s, government subsidy rates to crop insurance products have grown. These subsidies are in proportion to the crop price so the per-acre subsidy has grown markedly since 2006.

The question we ask is to what extent crop insurance subsidies are responsible for conversion of yield-risky, low-quality, environmentally fragile grassland into cropping? The motivations for asking this question are two-fold. One is that these subsidies enhance average returns to cropping at the expense of pasture and other uses, and so are likely to draw acres toward cropping. The other is that the subsidies are in proportion to risk. Non-cropped land of greatest environmental concern tend to be yield-risky and of low innate productivity. Such subsidies may well provide a larger subsidy to land of greatest environmental concern when compared with other land under the same subsidy program.

A long literature has looked at any insurance connection with land conversion, e.g., Young, Vandeveer and Schnepf (2001), Goodwin, Vandeveer and Deal (2004), GAO (2007), and Claassen *et al.* (2011). The consensus has been that while crop insurance subsidies have incentivized to cropping, the effect is not large. However there are gaps in the literature. Data availability issues have meant that the focus has been largely at the U.S. county level, but decisions are made at the farm level and much is lost concerning risk management when farm-level data are aggregated. The inquiries were not focused on the most marginal cropping region, the cropping fringe in Western Great Plains. Inevitably, given data used, limited and coarse measurements of insurance subsidy size were employed. Also, policy has changed markedly since the more analytic earlier studies, e.g., Goodwin et al. data concerned 1985-'93. Finally, Claassen et al. is the only study to cover the markedly different production environment that has emerged over the five years up to 2010.

We used U.S. Dept. of Agriculture Risk Management Agency data for corn and wheat to model yield randomness at the farm level and then computed an insurance loss index per expected bushel produced. The data were those upon which actual crop insurance payouts were made by crop insurance companies and contain a yield history on each unit (field) under federal insurance. Yield history had up to 10 years yield record for each insured unit. We used records that included 4+ years actual yield for a given crop. In order to account for technical change we de-trended yield data through kernel regression methods, as in Claassen and Just (2011). The index was applied to estimate actuarially fair insurance premia at the farm level, and so compute the extent of premium subsidies provided. Upon averaging farm-level insurance loss indices across a county, the county average index was regressed on land quality and climate indicators to confirm that the index tends to be higher where land is low quality, and where crops are heat and water starved.

The RMA yield data were then used to impute best alternative land opportunity costs for each unit in Beadle, Edmunds, Faulk, Hand, Hyde and Sully Counties of South Dakota, all near the Missouri Coteau. Constant absolute risk aversion was assumed with risk aversion coefficient 0.0003 while it was also assumed that just one crop was planted, corn. We considered only yield insurance and not the more widely chosen and heavily subsidized revenue insurance, as we did not have a model of price yield correlations. The Supplemental Revenue Assistance Payments Program (SURE) was not modeled, and so the analysis does not address the Sodsaver provision in the 2008 Farm Bill. Production costs were obtained from Janssen and Hamda (2009) for Central and North Central South Dakota. With baseline subsidy rate of 55% (or 75% yield coverage), we looked at the impact of setting insurance subsidy rates equal to zero, where it should be noted that these are not the only subsidies and the crop insurance market might not survive absent the other subsidies made by the government directly to crop insurance companies.

Our main, and very preliminary, finding was that the percent change in area cropped was a 0.88% reduction across the six counties. Bearing in mind that the data pertain to land that is already cropped, this means that in 2009 about 1% of land under federal crop insurance in the county might have been reallocated to grassland of some form were the crop insurance subsidy rate set equal to 0%. Magnitudes for the six counties are provided in Figure 12 below, a county map of South Dakota. As a point for comparison, we also asked what would happen were the crop price reduced by 5% instead. In that case there would have been a comparable 0.89% reduction in cropped acres across the six counties. It bears remembering that these very preliminary results do not model whole-farm cropping rotations, do not capture revenue insurance effects and have not picked out farms in each county that are likely most marginal in cropping. Qualification notwithstanding, why are simulated responses so low? Primarily because crop prices are presently so high that crop insurance subsidies are a secondary consideration.

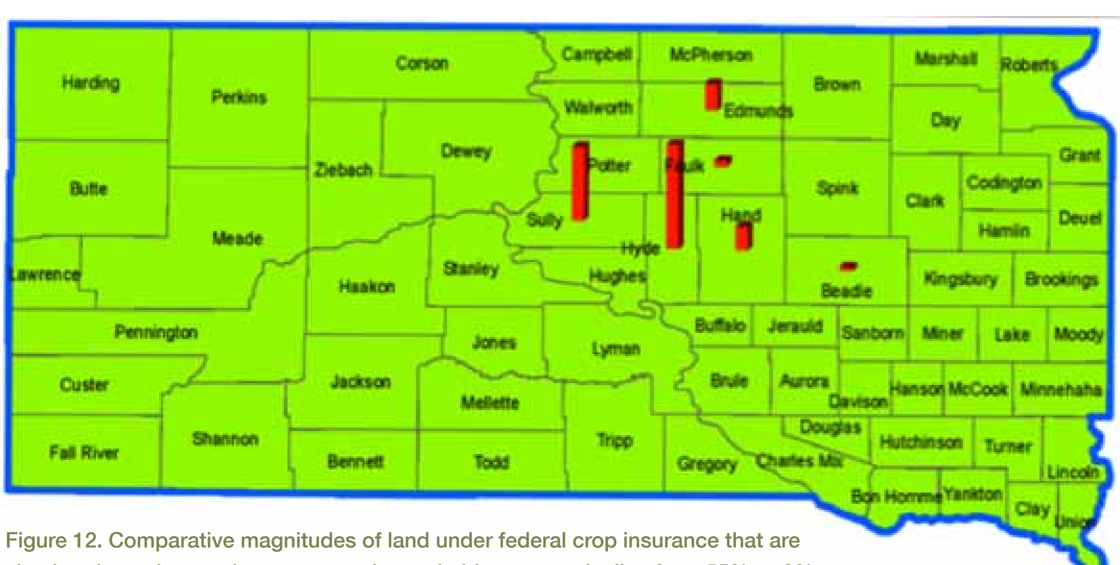


Figure 12. Comparative magnitudes of land under federal crop insurance that are simulated to exit cropping were premium subsidy rates to decline from 55% to 0%.

References

Carena, M.J., Bergman, G., Riveland, N., Eriksmoen, E. & Halvorson, M. (2009) Breeding maize for higher yield and quality under drought stress. *Maydica*, **54**, 287-296.

Claassen, R., Carriazo, F., Cooper, J.C., Hellerstein, D. & Ueda, K. (2011) Grassland to cropland conversion in the Northern Plains: The role of crop insurance, commodity, and disaster programs. U.S. Dept. of Agriculture, Economic Research Service Report #120, June, Washington, DC.

Claassen, R. & Just, R.E. (2011) Heterogeneity and distributional form of farm-level yields. *American Journal of Agricultural Economics,* **93**, 144-160.

Goodwin, B.K., Vandeveer, M.L. & Deal, J.L. (2004) An empirical analysis of acreage effects of participation in the Federal crop insurance program. *American Journal of Agricultural Economics,* **86**, 1058-1077.

Janssen, L. & Hamda, Y. (2009) Economic analysis of SODSAVER provisions of the 2008 Farm Bill for South Dakota. Economics Staff Paper 2009-1, South Dakota State University, Brookings, July.

U.S. Government Accounting Office (GAO). (2007) Farm program payments are an important factor in landowners' decisions to convert grassland to cropland. Report to Congressional Requesters, GAO-07-1054, September.

Young, C.E., Vandeveer, M.L. & Schnepf, R.D. (2001) Production and price impacts of U.S. crop insurance programs. *American Journal of Agricultural Economics,* **83**, 1196-1203.

Yu, T. & Babcock, B.A. (2010) Are U.S. corn and soybeans becoming more drought tolerant? *American Journal of Agricultural Economics,* **92**, 1310-1323.

Grasslands in the 2012 Farm Bill: How Conservation Compliance and Crop Insurance Can Be Modified to Achieve Conservation Benefits

Presenter: Brad Redlin, Izaak Walton League (bredlin@iwla.org)

The 2012 Farm Bill debate emphasizes risk-management insurance amid intense budget pressure. The historically effective conservation compliance regimen achieves savings by withholding payments to producers who fail basic conservation requirements. The 1996 Farm Bill, however, exempted federal crop insurance from compliance. This presentation analyzes the changing role and structure of crop insurance and proposes policy responses to the threat now facing grasslands. The federal crop insurance program has expanded rapidly and the majority of U.S. cropland is covered. In turn, negative consequences cited include promoting risky production and increased conversion of sensitive land. This presentation proposes re-linking insurance subsidies to compliance requirements, and examines expanding compliance. Expansions include "Sodsaver" (making land without prior cropping history ineligible for subsidized insurance), requiring minimum setbacks from water bodies for row-crop production, and extending the highly erodible land conservation plan mandate to all land in federal programs. Obstacles include high crop prices and genetic and farm practice advances that may overpower compliance disincentives. It is not yet known whether Congress will continue to support high levels of Farm Bill spending despite the deficit. However, the deficit factors into support of compliance mechanisms as providing "the best bang for the buck" since violations trigger savings and voluntary programs are increasingly expensive due to land costs. Further, compliance requirements on insurance will have the greatest impact and reach: revenue insurance coverage is at record high, creating a strong incentive to maintain insurance eligibility, and non-program crops (fruit, vegetables) otherwise have no production subsidies subject to compliance, but participate in federal crop insurance.

The Role of Federal Policy in Grassland Conservation

Conservation Reserve Program field in Cochran County, TX. Credit: Russell Martin, Texas Parks and Wildlife Department.

The Conservation Reserve Program (CRP): The Past, Present and Future

Presenter: Scott McLeod, U.S. Fish and Wildlife Service, North Dakota Partners for Wildlife Program (scott_mcleod@fws.gov)

The Conservation Reserve Program (CRP) was established by Congress in the Food Security Act of 1985. CRP was created out of necessity due to overproduction of grain commodities and Government programs which encouraged the cultivation of fragile, highly erodible soils. The result of such practices was bloated grain stocks, plummeting crop prices and record low farm income. The main goal of CRP was to reduce soil erosion on highly erodible lands. Secondary goals included protecting groundwater and surface water, safeguarding the Nation's capacity to produce food and fiber, and providing income support to producers by curbing the production of surplus commodities.

Over the course of the last 26 years, CRP has been reauthorized in the 1990, 1996, 2002 and 2008 farm bills. The nationwide enrollment cap has fluctuated with the passing of each farm bill from a high of up to 45 million acres in 1985 to the current level of 32 million acres. During that time period, CRP has undergone many changes and has provided significant benefits to the soil, water and wildlife resources of the U.S. For example, according to the U.S. Department of Agriculture's Farm Service Agency, acres enrolled in CRP in 2009 reduced sedimentation by 220 million tons, Nitrogen (N) by 612 million pounds, Phosphorous (P) by 123 million pounds, soil erosion by 215 million pounds compared to 1982 levels and also sequestered 47 million metric tons of CO_2 equivalent. It has been particularly significant for wildlife in the Northern Great Plains. For example, in the Prairie Pothole Region of North Dakota, South Dakota and Montana, CRP is credited with increasing waterfowl populations annually by more than 2 million ducks (Reynolds et al. 2001).

"Globally, grasslands are the least protected and most modified major biome. In the United States, less than 2% of grasslands have been conserved and most protected areas are not sufficient in size for wide-ranging resident wildlife species or the processes needed to sustain habitat."

–Martin, B. and S. Cleveland. Community-based conservation and the use of grassbanking in the northern prairies of Montana (page 64).

However, more than 5.5 million acres of CRP have expired since 2007 when the program peaked at 36.7 million acres. Successive years of high commodity prices coupled with significantly escalating land values and cash rent rates are the primary factors contributing to the decline in CRP acres. Another 14.2 million acres (45.7%) of CRP are scheduled to expire from 2011-2013 and it remains to be seen whether many of these acres will be reenrolled or will be returned to production. A glance into the future suggests that many of these acres will soon be producing crops once again.

The world's human population continues to grow and is projected to increase from 6.9 billion today to 9 billion by 2050. More people mean growing demand for food, feed, fuel, fiber and energy. To meet these growing demands producers are faced with two options: either bring more land into production or produce more on existing agricultural lands. The likely scenario is a combination of both. If CRP is to remain a viable program and a significant part of the landscape into the future, it is likely the program will need some adjustments to keep it attractive to private landowners. Failure to change and adapt may signal the end of one of the most successful conservation success stories. Program modifications that allow private landowners to retain certain rights (i.e. grazing, biomass harvest, etc.) and provide increased management flexibility throughout the year and the contract period will likely keep landowners interested while still maintaining the conservation benefits for our soil, water and wildlife resources. Increased management flexibility also produces the added benefit of reducing program cost; something that speaks volumes as the U.S. looks at significant actions to reduce the national deficit.

References

Reynolds, R.E., Shaffer, T. L., Renner, R.W., Newton, W.E. & Batt, B.D.J. (2001) Impact of the Conservation Reserve Program on duck recruitment in the U.S. prairie pothole region. *Journal of Wildlife Management* **65**, 765-780.

Grassland bird use of Conservation Reserve Program fields in the Great Plains and Interior Lowlands: A long-term, regional perspective

Presenter: Lawrence Igl, USGS Northern Prairie Wildlife Research Center

Co-Author: Douglas Johnson, USGS Northern Prairie Wildlife Research Center

Long-term cropland retirement programs have long been recognized as successful conservation strategies for soil, water, and wildlife resources, but none has received as much attention from conservation and wildlife groups as the Conservation Reserve Program. The CRP is a voluntary program that is available to agricultural producers to help protect environmentally sensitive or highly erodible land. Producers enrolled in the CRP establish long-term perennial cover to improve water quality, control soil erosion, and enhance wildlife habitat. In return, the U.S. Department of Agriculture provides rental payments and cost-share assistance during the contract period. Although the CRP is a long-term cropland retirement program, many of the early studies on the benefits of CRP for grassland birds were short term, with durations of three or fewer years. Despite the spatial extent of the program across the Great Plains and much of the United States, many of these early studies occurred in only a few CRP grasslands in a single area or county. Long-term, regional studies of breeding bird use of CRP grasslands are rare. Since 1990, we have been involved in a long-term, regional effort to evaluate breeding bird use of several hundred CRP grasslands in nine counties in four states (Minnesota, Montana, North Dakota, and South Dakota) in the northern Great Plains. The temporal extent and spatial scale of this ongoing study are unmatched by any single field study of breeding birds in CRP grasslands. This study has shown that grassland birds make considerable use of CRP fields during the breeding season, including many species of grassland birds that have been declining in abundance in recent decades. We use published and unpublished results from this study to illustrate that long-term and regional studies, such as this, are essential for gaining an understanding of the true value of the Conservation Reserve Program and its management.

The Partners for Fish and Wildlife Program: Celebrating a Legacy of Partnership in Dakota Grassland Preservation and Management

Presenter: Chris Flann, US Fish and Wildlife Service, Chase Lake Prairie Project (christopher_flann@fws.gov)

Other Authors: Kevin Willis, North Dakota State PFW Coordinator (retired), and Kurt Forman, South Dakota State PFW Coordinator

The U. S. Fish and Wildlife Service's Partners for Fish and Wildlife (PFW) program in North and South Dakota is a voluntary, grassroots wildlife habitat restoration program with a strong connection to the ranching community. PFW biologists work with ranchers to develop rotational grazing plans and improve infrastructure while promoting the benefits of managed grasslands on their private property. Since the program's inception in 1987, PFW biologists in the Dakotas have completed over 8,500 conservation projects with participating landowners. Over a thousand of these projects have been grazing management agreements with ranchers, accounting for around 580,000 acres of managed grassland.

By promoting rotational grazing, grassland restorations and interactive educational experiences for grazers, PFW biologists are able to further U. S. Fish and Wildlife Service conservation goals while helping to keep ranchers ranching and therefore, native grasslands intact. Relationships developed by PFW biologists with cooperating ranchers are often a launch point for more permanent grassland protection through easements. The PFW program has proven over and over again that it truly is a win-win partnership.

This Stutsman County, North Dakota landowner partnered with the U.S. Fish and Wildlife Service to erect fencing and develop a grassland management system on his native grassland. Subsequent to this partnership, the landowner sold a perpetual grassland easement to the Service, preserving the grassland forever. Chris Flann, U.S. Fish and Wildlife Service.

Many agreements with the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program are negotiated over the kitchen table. Credit: Chris Flann, U.S. Fish and Wildlife Service.

Integrated targeting of grassland easement acquisition for waterfowl increases conservation benefits in the Prairie Pothole Region

Presenter: Johann Walker, Ducks Unlimited

Other Authors: Aaron Smith, Scott Stephens, and James Ringelman, Ducks Unlimited; Jay Rotella, Montana State University; Mark Lindberg and Christine Hunter, University of Alaska Fairbanks; Charles Loesch, US Fish and Wildlife Service.

Perennial grasslands in the Prairie Pothole Region (PPR) provide important habitat for breeding waterfowl, waterbirds, and grassland songbirds. Perpetual conservation easements are widely used to protect privately owned grasslands from conversion to cropland in the PPR of North and South Dakota, USA. These easements are targeted to areas with the highest long-term average density of breeding duck pairs. We evaluated the current targeting strategy for acquisition of conservation easements on privately owned grasslands, and we proposed a new strategy for targeting future acquisitions. Results of our evaluation supported development of a new strategy. Area protected declined annually concurrent with large increases in easement cost (248%) and landowner-reported cropland rental rate (40%). The observed proportion of protected land with relatively low suitability for cultivation (i.e., at low risk of conversion) was greater than the observed proportion of unprotected grassland with relatively low suitability for cultivation. There was a statistically significant difference between the distribution of protected and unprotected grassland with respect to the quartiles of potential cost of protection, but the observed proportion of land above and below the median cost was the same for both groups. Of the 58,881 km^2 of remaining unprotected grassland habitat, 15,938 km^2 was located in landscapes identified as the highest conservation priority under the current system. This area was nearly 6 times larger than the 2,792 km2 protected during 2000–2009. We proposed a targeting scheme that refocused protection efforts on the 3,189 km2 of unprotected highest-benefit habitat composed of greater than 75% high-risk grassland and located in counties with cost index values below the 25th percentile. We conducted a simulation study to determine the potential gain in conservation value from the refined approach and concluded that focusing on this smaller area would potentially lead to a 24% decrease in easement cost per hectare and a 20% increase in the amount of protected area. We concluded that adoption of this new prioritization and an adaptive approach to monitoring progress would help counter increasing demand for cropland and protect more critical habitat in our study area.

The Past, Present and Future of Grassland Easements in South and North Dakota

Presenter: Noel Matson, US Fish and Wildlife Service

The U.S. Fish and Wildlife Service (Service) is proposing to accelerate the conservation of wetland and grassland habitat within the Prairie Pothole Region in the eastern portions of North Dakota, South Dakota, and Montana. The proposed Dakota Grassland Conservation Area (Dakota Grassland) is part of a landscape-scale, strategic habitat conservation effort to conserve populations of migratory birds by protecting the unique, highly diverse, and endangered ecosystem known as the Prairie Pothole Region. Establishment of the Dakota Grassland would allow the Service to further the protection of wetland and grassland habitat by working with private landowners to develop conservation easement agreements.

To maintain current levels of breed¬ing migratory birds in the Prairie Pot¬hole Region, the Service has developed a conservation strategy for wetland and grassland habitat in North Dakota, South Dakota, and Montana. Under this strategy, the proposed Dakota Grassland project identifies 240,000 acres of wetland and 1.7 million acres of grassland for conservation. Additional efforts would be needed to fully meet the conservation strategy, which identifies the need to conserve a total of about 1.8 million acres of wetland and 10 million acres of grassland throughout the Prairie Pothole Region.

The proposed Dakota Grassland project would complement an existing Service program—Small Wetlands Acquisition Program (SWAP). A goal of SWAP and the Dakota Grassland project is to promote profitable farming and ranching practices on private lands in order to conserve wetland and grassland resources for the benefit of migratory birds. These efforts are critical for conserving habitat, because at current conversion rates, one-half of the remaining native prairie in the region will be converted to other uses in only 34 years. It would take the Service 150 years with current funding levels to protect the remaining wetland and grassland habitat in the project area through the SWAP alone; thus, the Dakota Grasslands project is needed to augment those conservation efforts.

How would conservation easements work?

The Service recognizes that the most effective technique for conserving the remaining wetland and grassland habitat in the proposed project area will be to work with private landowners on conservation matters of mutual interest. The proposed Dakota Grassland Conservation Area would involve using conservation easements across the project area landscape to protect wetland and grassland habitat from being converted to other uses.

As a voluntary legal agreement between a landowner and the Service, an easement is a perpetual conservation agreement that the Service would buy from a willing landowner within the proposed project area. In conjunction with habitat protection measures, the conservation easements would allow for the continuation of traditional activities such as farming wetlands when dry from natural conditions and livestock grazing and haying in grasslands. Unlike fee-title ownership, under a conservation easement the landownership, property rights, and control of public access would remain with the landowner. In addition, the property would remain on the local tax roll.

Conservation easements limit the type and amount of development that may take place on a property in the future. However, activities that would affect a conservation easement such as roads, pipelines, or wind projects and certain development activities could be allowed under limited circumstances. The Service proposes to identify a re¬view process for evaluating activities on all current and future conservation easements in the Prairie Pothole States of Region 6. This review process would apply to not only conservation easements purchased under the proposed Dakota Grassland project, but also to those acquired under other Service programs such as SWAP.

The Service would purchase conservation easements with funds from the Land and Water Conservation Fund Act of 1965; these funds are primarily derived from oil and gas leases on the outer continental shelf, excess motorboat fuel tax revenues, and sale of surplus Federal property. Easement payment is determined by a calculation that includes comparable land sales and the assessed value of the property. Depending on land productivity, the pay¬ment for an easement typically ranges from about one-third to one-half of a property's full-market value.

What resources would benefit from the proposed conservation area?

During the last quarter century, grass¬land birds have experienced faster and more widespread declines as compared to other groups of birds. The loss of grassland habitat has played a signifi¬cant role in this decline. The proposed Dakota Grassland Conservation Area would focus on conserving populations of migratory birds by protecting the most productive tracts of remaining wetland and grassland habitat in the Prairie Pothole Region.

The Prairie Pothole Region is unique in that it contains millions of small, water-filled depressions—called wetlands or prairie "potholes"—that were formed by glaciers, and it constitutes one of the richest wetland systems in the world. These wetlands are surrounded by grasslands that provide highly productive habitat for migratory birds. Supporting an incredible diversity of bird life, the Prairie Pothole Region is breeding habitat for a myriad of wetland and grassland birds and also supports significant numbers of spring and fall migrants.

The Prairie Pothole Region is one of the most altered landscapes due to the loss of wetland and grassland to other uses. However, it is also one of the most important migratory bird habitats in the Western Hemisphere. Despite significant changes to the landscape, millions of wetlands and large tracts of grassland still remain. This region continues to be the backbone of North America's "duck factory" and critical habitat for many wetland- and grassland-dependent migratory birds.

Grasslands for tomorrow – A Model for Protecting the Prairie and Wetland Ecosystem

Presenter: Rick Warhurst, Ducks Unlimited (rwarhurst@ducks.org)

When the last glacier retreated from the eastern Dakotas and portions of Iowa, Minnesota and Montana approximately 10,000 years ago it left behind a landscape containing extensive grassland that stretched from horizon to horizon. This prairie was interspersed with tremendous numbers (millions) of shallow prairie pothole wetlands. This area which extends north and west into Canada is referred to as the Prairie Pothole Region (PPR) and contains about 300,000 square miles.

In 1955, the U.S. Fish and Wildlife Service, in cooperation with the Canadian Wildlife Service and state, provincial and non-governmental organization partners, initiated the May Waterfowl Breeding Population and Habitat Survey across Canada and northern United States. Waterfowl populations and habitat conditions are surveyed and monitored by strata and transects from both the air and from the ground. There are 56 years of survey data from the world's largest wildlife survey available. Over 55,000 air miles are flown each spring in May and very early in the northern areas of the North American continent.

In 2011, 7 percent of the survey area in eastern North and South Dakota (Strata 45-49) held 28 percent of the ducks counted on the survey. Ducks banded in the U.S. Prairie Pothole Region have been recovered in all four flyways and all states of the U.S. High densities of banded ducks have been recovered in Minnesota, Iowa, Illinois, Arkansas, Missouri, Texas and Louisiana.

Wetlands such the shallow prairie potholes provide the food resources that attract breeding ducks each spring to the PPR. The U.S. Fish and Wildlife Service Habitat and Population Evaluation Team (HAPET) has developed the Breeding Duck Population Distribution map for eastern North and South Dakota (the aptly named "Thunderstorm Map"). About 3.8 million pairs of five major puddle duck species that breed in the eastern Dakotas are present in average years (mallards, northern pintails, blue-winged teal, gadwalls and northern shovelers).

Grasslands provide nesting cover for the breeding ducks. Most species of prairie ducks establish nests in the uplands much like a ring-necked pheasant or sharp-tailed grouse. Geographical Information Systems (GIS) data provide maps of the landscape that attracts high densities of breeding ducks (over 40 breeding pairs per square mile) in eastern Dakotas. LANSAT satellite imagery depicts which four-square-mile landscapes contain 40 percent to 100 percent grassland cover in the eastern Dakotas. We can target conservation programs for maximum effectiveness by overlaying duck distribution (>40 pairs per square mile) with grassland distribution (landscapes containing 40 percent to 100 percent grass on four-square mile units. The high breeding duck pairs and high grassland areas are where Ducks Unlimited targets protection of habitat.

At its peak in the late 1990s and early 2000s, the U.S. Department of Agriculture's Conservation Reserve Program (CRP) put 7.8 million acres of grassland on the U.S. PPR landscape. Research indicated that 2.2 million ducks were recruited to the fall flight annually from CRP. But CRP contracts are expiring and the extensive grassland cover is rapidly disappearing in the Dakotas. North Dakota will likely lose 60 percent of its CRP while South Dakota will lose 66 percent of it CRP. It is notable that the greatest loss of CRP is in those landscapes containing high wetland densities and high duck breeding population numbers.

There are areas in the Dakotas that contain high duck breeding population densities and abundant grassland nesting cover. However, conditions are changing in the Dakotas. Wetlands are being drained or pattern drain tile is being installed around wetlands across the eastern Dakotas. Grasslands are rapidly being converted to agriculture cropland whether in Hand or Hyde County, South Dakota, Ward or Sheridan County, North Dakota, or Phillips County, Montana. North Dakota has lost 72 percent of its original grassland in the PPR. South Dakota has lost 64 percent of its eastern grasslands. Minnesota has converted 86 percent of its grassland to other uses and Iowa 93 percent of its original grassland. Most of the grassland conversion has been to agriculture production, particularly row crop agriculture production.

Habitat fragmentation occurs as tracts of grass are converted to cropland and wetlands are drained or filled. The result is a reduction in duck nesting success, duck population declines, shorter hunting seasons and smaller bag limits.

Ducks Unlimited uses two primary models or methods to protect grasslands and wetlands in the PPR. Method one is the Revolving Land Strategy. We have a goal of protecting 150,000 acres of grassland and wetlands by 2019 using this procedure. Tracts of land containing high wetland densities and abundant grass that are at high risk of being converted to cropland and are for sale are identified. The land is purchased in fee title. Habitat restoration is performed including both wetland and grassland restoration. Perpetual Grassland and Wetland Conservation Easements are placed on the land (and the deed, too). The land is then sold to a wildlife management agency, conservation buyer or rancher. Funds from the land sale are then used to purchase the next tract of land that has high conservation values and is at risk for habitat conversion. The procedure is then repeated. Ducks Unlimited has purchased 37,715 acres since 1999 in eastern Dakotas in fee title. We currently hold 19, 259 acres while 18,456 acres have been perpetually protected by conservation easement and sold. Some of the properties owned by Ducks Unlimited are showcase properties used for education, management, monitoring research, recreation, fund-raising and inspiration. This is a revolving land protection strategy and few parcels are held long-term.

A second model for protection of grasslands and wetlands is the purchase of perpetual Grassland Easements from willing sellers. These perpetual easements are U.S. Fish and Wildlife Service easements. They are held, monitored and enforced by the U.S. Fish and Wildlife Service. The grassland is perpetually protected against being broken for cropping or any other purpose. Haying is allowed but is delayed until after July 15. Grazing recreation and other uses are permitted. A one-time payment is given to the landowner and is normally in the range of 30 percent to 45 percent of the land value (today it is approximately $400 per acre range). Ducks Unlimited's goal is to protect 1,850,000 acres in the Dakotas using this procedure by 2019.

In September 2008 Ducks Unlimited introduced its Recue the Duck Factory Initiative (RFD). The objective of the five-year RFD Initiative is to address the large backlog of people desiring to sell grassland easements and protect grasslands and wetlands in eastern Dakotas. There were over 600 such people in 2008 as RFD was launched. The goal was to secure 300,000 acres of grasslands and wetlands before it was too late. Ducks Unlimited sought to raise $40 million from private donations and leverage those funds at a 3:1 ratio with public grants and other funding sources. To date 165,047 acres have been protected and $49.3 million spent accomplishing this.

In total since 1997 Ducks Unlimited and its partners including the U.S. Fish and Wildlife Service, North American Wetlands Conservation Council, Land and Water Conservation Fund, South Dakota Department of Game, Fish and Parks, North Dakota Game and Fish Department and several NGOs have perpetually protected 936,173 grassland and wetland acres in eastern North and South Dakota and have expended over $168 million in doing this.

But trouble is on the horizon for grasslands, wetlands and ducks. There is a rapidly growing world demand for food and commodities, world droughts have created grain scarcity, record oil prices are driving policy for energy independence, production of corn ethanol has rapidly expanded, inadequate supply versus demand has increased prices for most commodities, and the 2008 Federal Farm Bill provided incentives to convert grassland to cropland. Grassland destruction is accelerating.

But opportunities exist. Significant grasslands still exist. Many landowners want to protect their grasslands. We can leverage private gifts with public grants and other sources of funds to facilitate the conservation of grasslands.

BUT THE TIME TO ACT IS NOW!!!

Trends and Threats to Grasslands in the Northern Great Plains: Contrasting policies and lessons learned from the Canadian Prairies

Presenter: Scott Stephens, Ducks Unlimited Canada (s_stephens@ducks.ca)

Other Authors: Karla Guyn and Paul Thoroughgood, Ducks Unlimited Canada

Credit: Aviva Glaser, NWF.

Historically, the Prairie Pothole Region (PPR) represented one of the largest and most diverse grassland/wetland ecosystems in North America. Conversion to cropland production has significantly altered this region with important implications for a diversity of grassland and wetland dependent birds that breed there. An interesting natural experiment has been conducted across the PPR as a result of the fact that the region is bisected by the 49th parallel which represents the international boundary between the United States and Canada. As a result, differences in the policies and their impacts on the grasslands and wetlands of this ecosystem can be compared and contrasted to yield new insights into how effective policies to protect and maintain this important grassland ecosystem can be developed in both countries. This presentation reviewed historic trends in grasslands/wetlands and the policies that were put in place that influenced the Canadian PPR. The current status of grasslands/wetlands was reviewed relative to existing threats and policies. Finally, contrasts and comparisons were be made between the policies in both the U.S. and Canada that impact grasslands across the region with an emphasis on identifying the types of policies that have the greatest potential to help protect grasslands across the entire PPR.

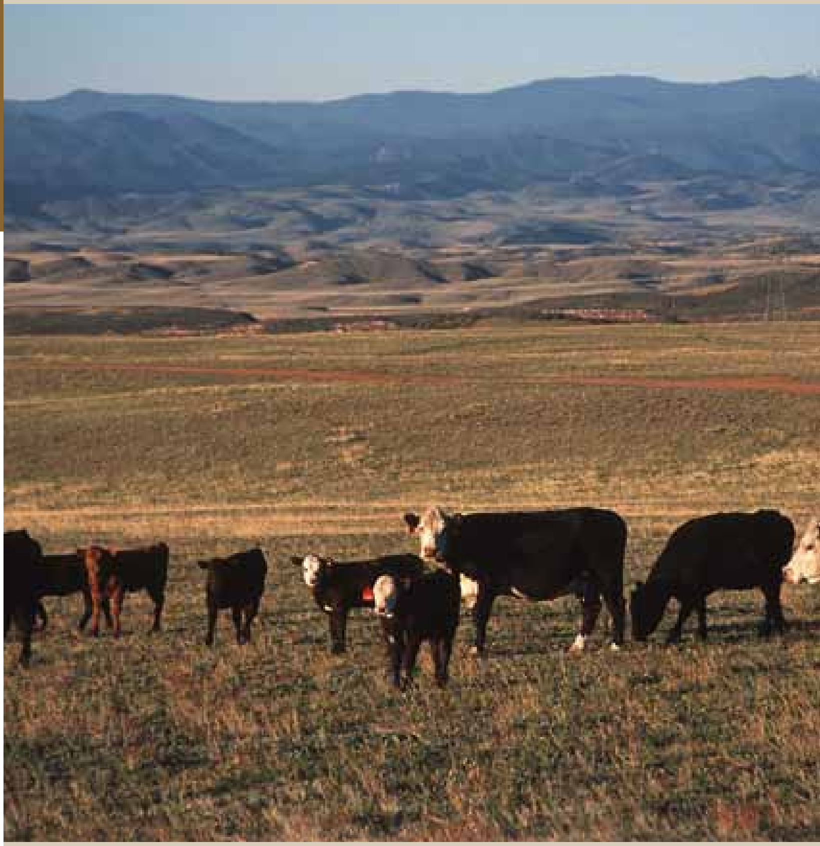
Grassland Management and Conservation

Re-establishment of a Keystone Species and its Contribution to Restoring the Grasslands of Arizona

Presenter: Holly Hicks, Arizona Game and Fish Department (hhicks@azgfd.gov)

Co-Author: Bill VanPelt, Western Association of Fish and Wildlife Agency.

Black-tailed prairie dogs were once abundant across southern Arizona. Poisoning campaigns that began in the early 1900's caused their extirpation from Arizona by 1961. In 1999, the *Multi-State Conservation Plan for Black-tailed Prairie Dogs* was initiated which outlined objectives for each state to manage their populations. In 2008, the Arizona Game and Fish Department began actively re-establishing the species in an effort to preclude the need to list the species under the Endangered Species Act and to restore a native species to the grasslands of Arizona. Since the project began, the Department has developed three sites where 300 black-tailed prairie dogs have been released over the last two years. Prairie dogs are known to be a keystone species of the grasslands and the expected results of their inclusion back into the landscape include an increase in species diversity of both flora and fauna, a decrease in mesquite invasion, and improved ecosystem functions. This presentation discussed the methods used for site selection and preparation, source population evaluation and selection, translocation, and post-release monitoring; the challenges faced during re-establishment; the successes of various techniques; and the future of the project.



Credit: Jeff Vanuga, NRCS.

"There is a need to reconstruct prairies and to conserve the few remnant native plant communities left on the landscape of the North American plains. This effort is becoming necessary to preserve soil from erosion, maintain water quality and support much needed biodiversity, as these resources sustain all farming systems."

–Borsari, B. and N. Mundahl. Restoring biodiversity and ecological services in a small prairie reconstruction in southeastern Minnesota (page 61).

Grassland Birds as Indicators of the Ecological Recovery of Bison

Presenter: Kevin Ellison, Wildlife Conservation Society (kellison@wcs.org)

Co-author: Steve Zack, Wildlife Conservation Society

For over 10,000 years, the plains bison (Bison bison bison) shaped and maintained North American grasslands. Numerous plant and wildlife species adapted to the ecosystem impacts of 10-30 million bison (Figure 13). Habitat specialization led to speciation and areas historically used by bison herds continue to support several endemic bird species (Mengel 1970). By the 1880's, plains bison numbered in the hundreds before conservation efforts were enacted. Today, there are 0.4 million plains bison, however, of these, >93% belong to herds managed for meat production (Gates and Ellison 2010). Therefore, in 2005, the Wildlife Conservation Society (WCS) revitalized its American Bison Society (ABS; from 1905-1930s it preserved and reintroduced bison in the U.S.) to ecologically restore bison as wildlife.

Since 1990, 18 (28%) of the 62 conservation herds of plains bison (Gates and Ellison 2010) were founded by a variety of stakeholders across the Great Plains. Aware of the need for management goals and common metrics across restoration efforts, as well as the imperiled status of grassland birds (the most imperiled group in North America [North American Bird Conservation Initiative, U.S. Committee 2009]; populations in decline since first measured in the 1960's), WCS has designed an adaptive management framework using grassland birds as indicators for scale and vegetation structure to guide bison restoration efforts.

The raising of >133 million livestock (112 million cattle, 0.5 million bison [USDA 2006]) on a fraction of the range once encompassed by bison has imparted many changes in the structure and composition of plant communities. Basically, the production and maintenance of habitats at the extremes of grazing (heavily and barely any) are less common, particularly at the scale of patch sizes required by many grassland-dependent wildlife, particularly grassland birds. Over 35 North American bird species are considered 'obligate' grassland birds, meaning that they require grasslands to nest and often to live within (North American

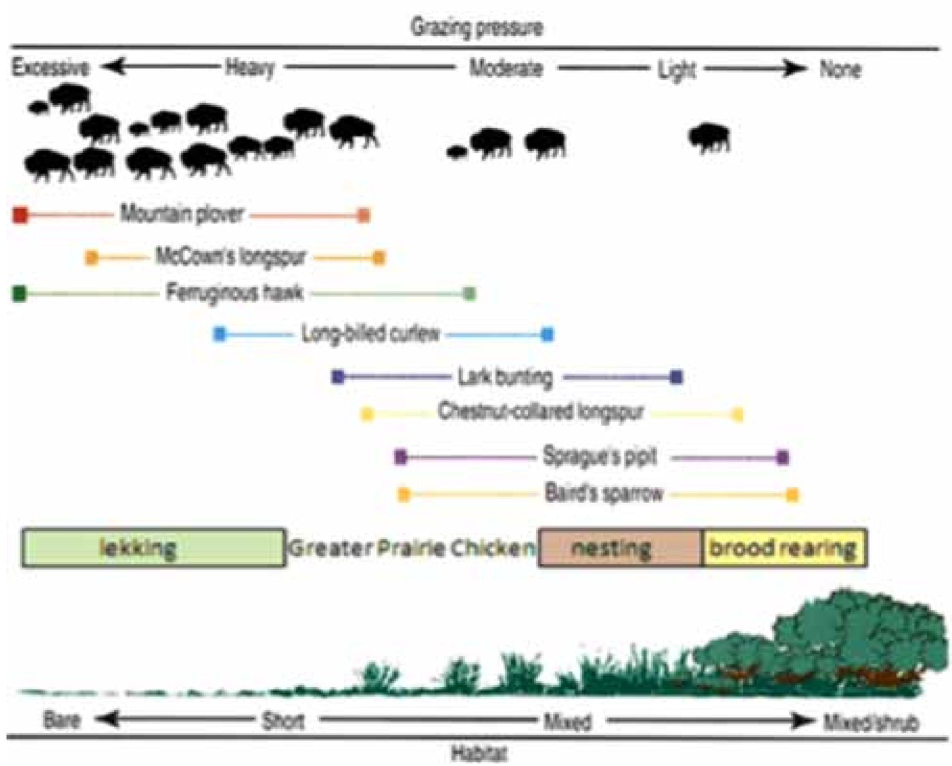


Figure 13: Heuristic representation of bird-habitat relationships mediated by grazing (after Knopf 1996). Grouse and shorebirds require multiple habitat types throughout their life cycles.

Bird Conservation Initiative, U.S. Committee 2011). Species with specific requirements make good indicators for certain attributes. For instance, the Grasshopper Sparrow *(Ammodramus svannarum)* and Sprague's Pipit *(Anthus spragueii)* are area sensitive, occurring mostly in relatively large (>300 acre) tracts of intact grassland with native vegetation (Davis 2004). Thus, relatively small birds can act as targets that help managers restore landscapes at more historically and ecologically appropriate scales for bison, birds, and all grasslands wildlife.

WCS is surveying grassland birds and vegetation at 16 sites (>400,000 acres) in the northern Great Plains. We are in the process of making management recommendations (e.g., pasture sizes, stocking rate, timing and extent of grazing, water tank placement, where and when to burn) based on the survey data and plan to follow the outcomes of our recommendations. Through such an adaptive framework we can efficiently help refine grazing management to better provide for and conserve grassland wildlife.

An early feature of this project is the identification of under-represented and complementary habitats in landscapes. Most landscapes lack the aforementioned extremes in grazing and therefore we work to implement these within ranches. Contrary to the more prevalent and homogenous habitat produced by moderate grazing, grazing at extremes may improve resiliency against the impacts of climate change. In essence, deferring grazing can provide stores of forage for periods of drought as well as facilitate plant reestablishment and growth to better handle climate stressors.

Generally, most conservation goals can be attained through grazing management, regardless of whether bison or cattle are employed (Towne et al. 2005, Fuhlendorf et al. 2010). Moreover, to effectively conserve grassland birds WCS also works with cattle producers. However, in certain scenarios either bison or cattle can be preferred. Cattle are certainly more readily available and easier to move and ship off. Bison by contrast can entail more long-term costs and planning. The biggest differences between the species relate to specific traits. For instance, cattle are generally more of a lowland species and spend more time by water. However, these traits can be overcome through breed selection and pasture/grazing design. Bison by contrast are will travel further to get to water and are more efficient at digestion, when not lactating, and require 60-70% of the forage that cattle do (Hawley et al. 1981). Again though, gazing plans for bison must be year-long whereas those for cattle can be purely seasonal if short-term grazing leases are employed.

One trait of ecological importance that is unique to bison is their wallowing behavior which compresses soil and can create microhabitats for plants and wildlife. Bison frequently wallow and therefore the impact of this behavior is not trivial. Through their frequent horning of trees and shrubs, bison are good at abating the encroachment of woody vegetation and can open areas where pinyon and juniper have moved in (Miller et al. 2009). In areas overgrazed and now dominated by cacti and/or yucca, bison will trample cacti and uproot yucca to consume the roots. Bison also shed wool-like fur that is used by many species in their nests (Coppedge 2009, Jung et al. 2010) and studies of the thermal capabilities of bison wool are underway (see Coppedge 2009). Also, a study with artificial nests found that those with bison wool were depredated significantly less often (Coppedge 2010) and WCS is testing this hypothesis with real bird nests in Saskatchewan.

The examples listed above clarify the relationships between bison and grassland ecosystems. Our work to measure the bird and habitat responses to bison will help guide future restoration efforts. Likewise, by providing a common metric among sites, we are able to help current projects monitor and improve their progress toward restoration goals. WCS intends to maintain this project through at least 2015. This span is needed to account for wide annual variation in the Great Plains as well as likely lags in bird and habitat responses to the reintroduction of bison (Figure 14).

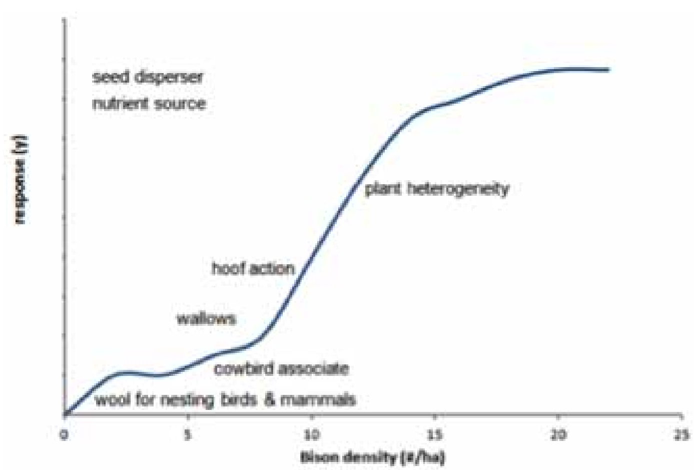


Figure 14: Theoretical representation of ecological changes associated with an increase in bison over time. Results would depend on range conditions, biodiversity, etc.

References

Coppedge, B. R. (2009) Patterns of bison hair use in nests of tallgrass prairie birds. *Prairie Naturalist* **41**, 110-115.

Coppedge, B. R. (2010) Bison hair reduces predation on artificial bird nests. Bull. *Oklahoma Ornith.* Soc. **43**, 13-16.

Davis, S. K. (2004) Area sensitivity in grassland passerines: Effects of patch size, patch shape, and vegetation structure on bird abundance and occurrence in southern Saskatchewan. *Auk* **12**, 1130-1145.

Fuhlendorf, S. D., B. W. Allred, and R. G. Hamilton. (2010) Bison as keystone herbivores on the Great Plains: Can cattle serve as proxy for evolutionary grazing patterns? American Bison Society Working Paper No. 4. 40 pages.

Gates, C. C. and K. Ellison. (2010) Numerical and geographic status. Pp. 55-62 In: American Bison: Status survey and conservation Guidelines 2010. C. C. Gates, C. H. Freese, P. J. P. Gogan, and M. Kotzman, eds. Gland, Switzerland. IUCN.

Hawley, A. W. L., D. G. Peden, H. W. Reynolds, and W. R. Stricklin. (1981) Bison and cattle digestion of forages from the Slave River Lowlands, Northwest Territories, Canada. *J. Range Management* **34**, 126-130.

Mengel, R. M. (1970) The North American central plains as an isolating agent in bird speciation. In Pleistocene and recent environments of the central Great Plains, W. Dort and J.K. Jones, Jr., eds. Pp. 279-340. Univ. Press of Kansas, Lawrence.

Miller, B., R. Reading, and M. Soulé. (2009) Bison Behavior in Semi-Arid Grasslands Could Benefit Restoration. *American Bison Society Newsletter* **6**, 6 http://www.americanbisonsocietyonline.org/LinkClick.aspx?fileticket=wRb6g10kuX4%3D&tabid=2249&language=en-US *Accessed October 2011*.

Jung, T. S., P. M. Kukka, and A. Milani. (2010) Bison (Bison bison) fur used as drey material by red squirrels *(Tamiasciurus hudsonicus):* An indication of ecological restoration. *Northwestern Naturalist* **91**,220-222.

North American Bird Conservation Initiative, U.S. Committee, (2011) The State of the Birds 2011 Report on Public Lands and Waters. U.S. Department of Interior: Washington, DC. 48 pages.

Towne, E. G., D. C. Hartnett, and R. C. Cochran. (2005) Vegetation trends in tallgrass prairie from bison and cattle grazing. *Ecological Applications* **15**, 1550-1559.

USDA. (2006) http://www.fas.usda.gov/dlp/circular/2006/06-03LP/cattle_sum.pdf *Accessed October 2011.*

The Glacial Ridge Project – Ten Years of Large-Scale Prairie Restoration

Presenter: Phil Gerla, The Nature Conservancy and University of North Dakota (pgerla@tnc.org)

Other Authors: Jason Ekstein, Meredith Cornett, and Marissa Ahlering, The Nature Conservancy

Nearly 25,000 acres of prairie reconstruction have been completed and the Glacial Ridge National Wildlife Refuge established since The Nature Conservancy purchased Tilden Farms in 2000. The site lies in northwestern Minnesota along the eastern margin of glacial Lake Agassiz, where sandy uplands run parallel to bands of mesic prairie and wetland, creating an important stop over and breeding area along the central North American flyway. During the last ten years more than 3,000 acres of wetland have been restored and 70 miles of ditches filled. Our experience provides guidance to others who desire ways to identify, initiate, and execute large-scale grassland restorations. In retrospect, at least three aspects of the project were essential:

(1) Availability of land and seed. A willing seller of a large tract in an ecologically critical area was crucial. Originally subdivided into 160-acre homesteads from 1875–1900, it took a steady, decades-long amalgamation of many small tracts into a few large tracts. The project, ironically, had its beginnings in the financial struggles experienced by those who tried to make a living from this marginal agricultural land. Nearby prairie remnants provided a source for ample, high- quality native seed. Project requirements for highly diverse, native forb seed spurred a small, but strong addition to local economic development.

(2) Recognition and integration of local interests. Project managers and local leaders needed to develop a strong level of mutual trust very early in the project; their views and expectations had to resonate. Residents and local agencies had to be effectively integrated into project planning and implementation. As part of the incentive, the groundwater supply for a nearby municipality was provided freely and protected, with the benefit of a 10-year capture zone under single ownership and perennial cover. Local leaders and residents also recognized the potential of the restoration to increasing tourism and improving the natural environment.

(3) Funding and taxes. Availability of financial resources was essential; this included developing an endowment for paying local taxes in perpetuity, funding the cost of reconstruction, and securing an extraordinarily large seed source. Funds to pay taxes and support organizational infrastructure came mostly from rental payments on the tract's remaining crop land. The project was accomplished in discrete stages, which related closely to nine USDA Wetland Reserve Program (WRP) contracts that largely funded grassland and wetland reconstruction.

A detailed restoration plan, established early in the project, continues to characterize progress, enables adaptive management, and provides a rubric to assess and evaluate the continued successes and shortfalls as management of Glacial Ridge passes to the U.S. Fish and Wildlife Service.

Restoring Biodiversity and Ecological Services in a Small Prairie Reconstruction in Southeastern Minnesota

Presenter: Bruno Borsari, Winona State University (bborsari@winona.edu)

Co-author: Neal Mundahl, Winona State University

The demise of prairies from the Midwest region of North America was the unavoidable outcome of designing large-scale farming systems, grown in gigantic monocultures and sustained by non-renewable oil (Jackson 2010). This paradigm of food production remains unsustainable, however, whereas prairie communities succeeded in sustaining life without relying on off-site inputs (Jackson & Jackson 2002). This paper presents data from a combination of studies that were carried out in the last four years at a small farm in Southeastern Minnesota (Winona Co.) where prairie patches were reconstructed to produce pellets from forbs and grasses to be used on-site as renewable fuel (Borsari et al. 2009). In 2007, we initiated a prairie restoration effort on 20 acres of a small family farm near Elba, Minnesota, in an attempt to aid the farmer to regain valuable ecological services and produce biomass from the plant community to be used as a source of renewable energy (Borsari and Onwueme 2008). Through the years, we also surveyed avian species and soil invertebrates to substantiate the validity of a prairie restoration effort within an agriculturally managed landscape, where soil loss and ground water contamination by agrichemical products constitute a continuous threat to human and environmental health.

There is a need to reconstruct prairies and to conserve the few remnant native plant communities left on the landscape of the North American plains. This effort is becoming necessary to preserve soil from erosion, maintain water quality and support the much needed biodiversity, as these resources sustain all farming systems (Jackson and Jackson 2002). Therefore, we think that the work accomplished at the farm may inspire policy makers to better understand the ecological values of grasslands and thus foster the restoration process by more land owners in this region of the upper Midwest and beyond.

The production of pellets from prairie biomass was the main purpose of restoring patches of native plant communities at the farm. The yields were compared to those of corn (Zea mays) through the years (Figure 15, page 62).

Our study area also included a prairie patch (6.7 acres) managed by the Minnesota Department of Natural Resources (MNDNR), a site with an old (20 years), well-established plant community of native grasses and forbs. This site adjacent to the farm under study provided valuable baseline data to compare with those we collected from corn and reconstructed prairie patches at the farm. The

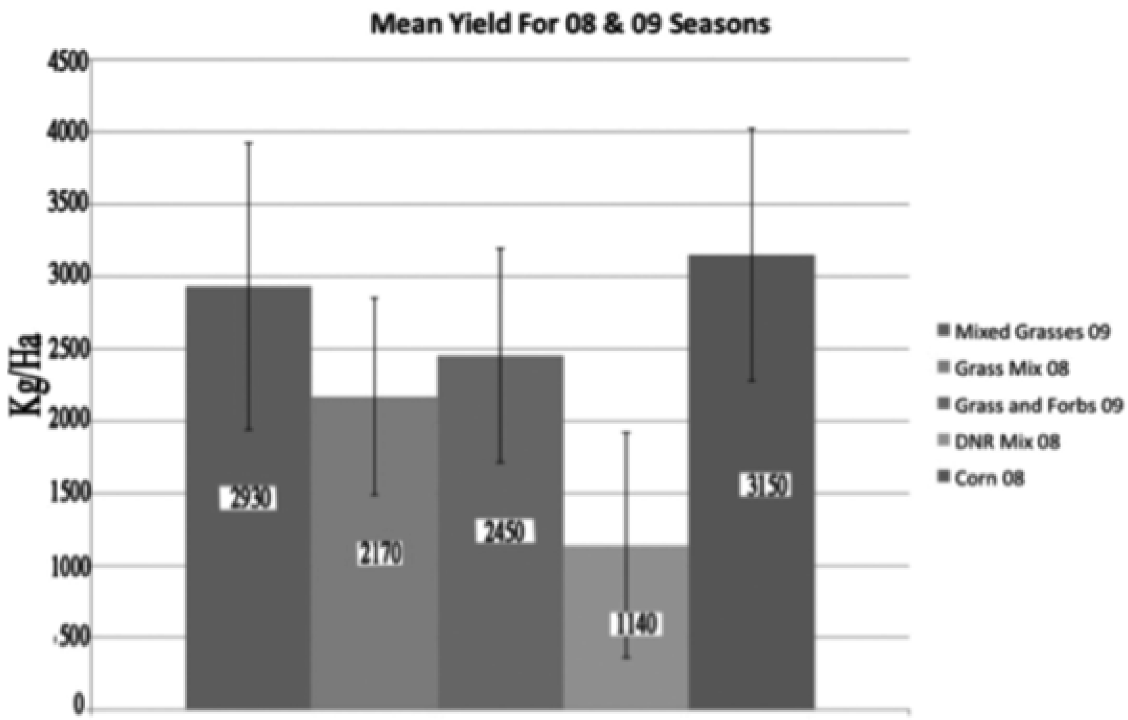


Figure 15. Comparison of yields (kg/ha) of prairie forbs, grasses and corn during two growing seasons (2008 and 2009), with variance (SE) for each crop system. From: Wilson et al. 2011.

differences in biomass yields were statistically significant when the data were analyzed through a single-way ANOVA, $F(2,15)=3.8$, $p<0.05$. Additionally, a *post hoc* test indicated that there was a significant difference ($p=0.05$) between the yields of plots with mixed grasses and plots with corn. Also, the yields between the mixed grasses and forbs and the corn from 2009 were statistically different ($p=0.05$). However, there was not a significant difference between the two prairie polycultures (Wilson et al. 2011).

For the bird communities inhabiting the prairie patches, the Simpson's index of diversity increased from 0.772 to 0.896 between 2008 and 2009 while species richness increased from 14 to 19, but density declined from 18.2 to 15.5 birds/ha between 2008 and 2009 (Mundahl *et al.* 2011). A Chi-square analysis of Shannon's indices (H') indicated a higher diversity of soil invertebrates in the restored prairie patches with the most diverse plant community ($X^2=80.7$, $p<0.05$), with mites (Garbasid and Orbatid), springtails (Collembola) and symphylans representing the richest taxa of invertebrates found. This evidence suggests that native polycultures enhance the diversity of soil microfauna (Table 4).

Although our restoration effort is relatively young, the benefits to the land and the environment have already

Table 4. Descriptive statistics and Shannon's Index of Diversity in the four different grassland patches.

Soil sample	Observed frequencies	Expected frequencies	Mean + S.D.	H'
DNR Land*	156	107.5	26.0+5.37	0.5567
Grasses & forbs	146	107.5	14.5+7.92	0.6684
Grasses	87	107.5	24.33+4.71	0.7114
Corn	41	107.5	6.83+60.16	0.6775

Legend(*): The DNR land is a 20 year old prairie (6.7 ac.) managed by the Minnesota Department of Natural Resources, which is adjacent to the farm under study.

emerged to show the feasibility for a form of modern agriculture, which remains productive and efficient without depending on oil and other non-renewable inputs. This work highlights the benefits of prairie restoration and reconstruction, which have the potential to become valuable economic venues while sustaining the quality of life in the agricultural context of our bioregion.

Acknowledgments

These studies were supported by grants from Clean Energy Resource Team (CERT) and Winona State University. The authors are grateful to the Kreidermacher family and Minnesota DNR for allowing us to conduct our works on their land and to Winona State University students (Jacqui Kasic, Naomi Corey, Daniel Wilson, Jason Morgan) for their assistance with field work.

References

Borsari, B., Onwueme, I., Kreidermacher, E. and Terril, T. 2009. Renewable energy from restored prairie plots in southeastern Minnesota, USA. Proceedings of the 2nd International Conference "Energy and Sustainability". Pp. 137-145. In: A. Mammoli and C. A. Brebbia, eds. WIT Transactions on Ecology and the Environment, Vol. 121. Wessex Institute of Technology Press. 538 pp.

Borsari, B., and Onwueme, I. 2008. A New Lease for Life Marginal Farmland: Convergence of Prairie Restoration with Biofuel Production. Proceedings of the 16th IFOAM Organic World Congress. Vol. 2: 608-611. In: D. Neuhoff, N. Halberg, T. Aföldi, W. Lockeretz, A. Thommen, I. A. Rasmussen, J. Hermansen, M. Vaarst, L. Lueck, F. Caporali, H. Hogh Jensen, P. Migliorini, H. Willer, eds. Modena, Italy.

Jackson, D. L. and Jackson, L. L. (2002) *The Farm as Natural Habitat. Reconnecting Food Systems with Ecosystems,* Island Press, Washington D.C.

Jackson, W. (2010) 'The prairie meets the farm: the next 50 years on the American land – perennializing policy and the landscape', in: B. Borsari, N. Mundahl, L. Reuter, E. Peters and P. Cochran (Eds.): *Proceedings of the 21st North American Prairie Conference,* pp. 1-9.

Mundahl, N., Corey, N. and Borsari, B. (2011) Bird Communities of Restored Prairies and Old-Field Habitats in Agricultural and Urban Areas of Winona County, Minnesota. *Proceedings of the 21st North American Prairie Conference* (In Press).

Wilson, D., Borsari, B., Terril, T., Kreidermacher, E. and Onwueme, I. (2011) Biomass Yields for Pellet Production from Reconstructed Prairie Patches in Southeastern Minnesota. *Proceedings of the 21st North American Prairie Conference* (In Press).

Factors affecting plant species richness and diversity in Great Plains grasslands: What do we know?

Presenter: Amy Symstad, USGS Northern Prairie Wildlife Research Center (asymstad@usgs.gov)

Other Authors: Jayne L. Jonas, Colorado State University; Deborah K. Buhl, USGS Northern Prairie Wildlife Research Center

Species richness and diversity are two metrics of biodiversity that may serve as useful indicators of ecosystem condition. Ideally, their response to a variety of natural drivers and anthropogenic stressors in the ecosystem of interest would be clear, thereby providing a means to separate trends in ecosystem condition caused by management or stressors from fluctuations caused by natural variability. Several vegetation monitoring programs in the United States are using plant species richness and diversity as measures of ecosystem health in Great Plains grasslands, but a synthesis of the information available regarding their sensitivity to natural and anthropogenic drivers and stressors is not available. Therefore, we compiled information from published literature into conceptual models illustrating this sensitivity. In the published literature, the largest effects on richness and diversity are caused by moderate grazing in tallgrass prairies and nitrogen fertilization in shortgrass prairies, whereas numerous drivers show little effect on these metrics. Interannual variability is high, with the average ratio of maximum temporal variation to maximum treatment effect within a study being 0.74 for richness and 0.69 for diversity. Although fluctuations in weather are often cited as the cause of this temporal variability, this connection is virtually unstudied. Therefore, we also used six existing datasets from Great Plains grasslands to assess the relative importance of multiple weather models for explaining interannual variability in these metrics. In our analyses, the relationships between plant species richness or diversity and various weather models were highly variable among datasets, among experimental treatments or vegetation types within datasets, and among richness and diversity metrics. Across datasets, native richness tended to have a stronger relationship to temperature models than to precipitation models, but the reverse was true for exotic richness. The strength of the relationship between richness and weather models was generally greater than between diversity and weather for both natives and exotics.

Community-based Conservation and the use of Grassbanking in the Northern Prairies of Montana

Presenter: Brian Martin, The Nature Conservancy

Co-Author: Shawn Cleveland, The Nature Conservancy

Globally, grasslands are the least protected and most modified major biome (Hoekstra et al. 2005). In the United States, less than 2% of grasslands have been conserved and most protected areas are not sufficient in size for wide-ranging resident wildlife species or the processes needed to sustain habitat. From 1983 to 2007, about 25 million acres of grassland in the U.S. were converted to other uses, primarily cropland (GAO 2007a). Within the Prairie Pothole Region (PPR) estimates of annual rates of conversion range from 0.4% to 1.33%, faster than the rate of destruction in the Amazon basin (Stephens et al. 2008, Rashford et al. 2011). In addition to habitat loss, inappropriate grazing and ranch management practices may degrade habitat quality, fragment habitat, or lead to direct mortality (Saab et al. 1995, Derner et al. 2009). Moderate and uniform use of forage for stable livestock production, for example, can negatively impact grassland birds that select either relatively tall or very short-statured vegetation (Knopf 1996). On intact grasslands, woven-wire sheep fencing and multi-strand barbed wire fence inhibit or prevent movement by pronghorn *(Antilocapra americana),* as well as other medium-to-large mammals (Martinka 1967, Barrett 1982). Significant Greater Sage-grouse *(Centrocercus urophasianus)* mortality also has been documented from collisions with fences (Stevens 2010).

While the Great Plains have seen significant grassland habitat loss, expansive areas of grassland habitat remain in portions of the PPR. Among the largest of these is the Montana Glaciated Plains (MGP), a region of approximately three million acres located between the Milk and Missouri rivers in north central Montana. The MGP provides breeding habitat for the highest number of declining endemic grassland birds in North America, encompasses one of the highest density Greater Sage-grouse populations, and supports other wildlife of high conservation concern, including black-footed ferret *(Mustela nigripes),* black-tailed prairie dog *(Cynomys ludovicianus),* and swift fox *(Vulpes velox).*

Of the three million acres within the MGP, about 500,000 acres are private land, 140,000 acres are currently being cropped or have a history of being cropped, 320,000 acres are intact and at-risk for conversion to cropland, and the remainder has a marginal risk for conversion. While private lands make-up a relatively minor percentage of the ownership, the intermingled distribution has the potential to disproportionately fragment the landscape if it was converted to cropland. Most ranches are comprised of both deeded and leased lands, primarily managed by the Bureau of Land Management and state school trust lands.

In the late 1990s, The Nature Conservancy (Conservancy) made a strategic decision to launch a community-based conservation program in the MGP. We identified three strategies we wanted to employ in the landscape: one, secure ownership of a relatively large ranch to serve as a key protected area that would contribute to the persistence of species of concern and their habitats; two, use our acquisition as a platform from where we could engage landowners in the MGP in order to develop additional permanent conservation opportunities; and three, demonstrate and influence management of private and public landowners. In 2000, the Conservancy acquired the 60,000 acre Matador Ranch (Matador). Initially we leased the Matador to a single landowner, but soon recognized that we would not be able to successfully implement strategies dependent on landowner engagement or influence management without adopting an approach that was externally focused. Working with a number of landowners in the MGP and hearing their needs and concerns, we determined that a relatively new concept referred to as grassbanking may allow us to meet our goals and obtain a greater conservation return for our investment. In 2003, we launched a grassbank at the Matador. The grassbank operates by providing leased forage to ranchers at a market-based discount in exchange for conservation benefits on their properties. At the Matador, conservation benefits are exchanged with landowners, who can select from a menu of land management actions, which are designed to abate the threats of habitat conversion and degradation. Landowners participate in a competitive process in which they offer conservation benefits in order to secure forage at the Matador. Landowners with the greatest value of conservation benefits are given priority. Agreements range from one to five years, depending upon the total value of conservation benefits offered. All landowners are required to select a "no sodbusting" conservation benefit, in which the landowner agrees not to convert any existing grassland to cropland. Additionally, if grasslands or other native habitats are converted, the participant can never again participate in the grassbank. Other conservation benefits include noxious weed management, management for black-tailed prairie dog, maintenance of Greater Sage-grouse habitat, grazing management beneficial for declining grassland birds, restoration of cropland through native species plantings, and removal or modification of fences that act as barriers to pronghorn migration or contribute to Greater Sage-grouse mortality. Additionally, landowners that establish a perpetual conservation easement on their ranch are guaranteed a negotiated number of livestock on the grassbank for as long as it is in operation.

Each year about 10 to 13 ranches have participated in the grassbank. In total, the participating ranches have generally totaled between 225,000 and 240,000 acres, which includes both private land and public leased land. Our most expansive discount relates to noxious weed monitoring and management, which encompasses the entirety of the participating ranches. In 2010, about 52,000 acres of private land at risk to conversion were protected in short-term contracts. Despite rising commodity prices, no lands managed by current or recent grassbank members have been converted for crop production. In terms of sustaining habitat, acreage of Greater Sage-grouse has remained relatively static at about 21,500 acres, whereas black-tailed prairie dog have fluctuated in response to sylvatic plague, ranging from a high of 3,836 acres in 2005, a low of 1,033 acres in 2008, and limited recovery to 1,959 acres in 2010. To date only one perpetual easement has been established on a relatively small grassbank ranch, totaling 670 acres. Three ranches spanning about 28,500 acres have entered into Natural Resource Conservation Service Grassland Reserve Program contracts that prohibit sodbusting for 20 years and require implementation of a grazing management plan.

The grassbank has also yielded several other intangible results, which are more difficult to quantify. We believe that the most important result has been to build trust and credibility through close cooperation with grassbank members. Each year, Conservancy staff work with the members to develop and implement a grazing management plan for the Matador, rather than requiring participants to follow a prescriptive plan. The interaction in this planning process allows for open and equal exchange on yearly and long-term goals for wildlife, habitat conditions, livestock production, and ranch operations. Because the conservation benefits we are trying to achieve on the participating ranches are the same as on the Matador, we also have the opportunity to test or demonstrate management actions, which can then be adopted on their ranches. Implementation on the Matador allows for landowners to engage in management actions without risk on their own ranches, and they are therefore more likely to be adopted after an approach has been tested. Because we monitor conservation benefits on the participating ranches, we also have opportunities to review and discuss management on those properties.

Typically, grasslands on Conservancy preserves in the Great Plains have been managed through short-term grazing leases to a limited number of landowners, and many National Wildlife Refuges in the PPR have similar leasing arrangements with neighboring landowners. We believe that grassbanking may be a valuable tool that can spur expanded management for conservation outcomes across the Great Plains. Based on the leverage we have achieved at the Matador, it is conceivable that grassbanking could significantly increase conservation management in the PPR. More importantly, grassbanking may serve as a means to long-term protection of grasslands by enhancing the stability of ranching operations by offering consistent supplemental forage, while also requiring retention of grasslands on private lands. Enhanced stability should increase financial viability, a key consideration by landowners in the retention of grasslands or conversion to cropland. Although grassbank protections are ephemeral, they may serve as an important bridge at a time of reduced governmental funding for conservation. For example, since the 1950s, the U.S. Fish and Wildlife Service has conserved 3 million acres within the PPR through the Small Wetlands Acquisition Program (GAO 2007b). Utilizing 25% (175,000 acres) of the fee lands acquired and leveraging those at a rate of three to one would result in short-term protection of an additional 525,000 acres. Grassbanking also has the potential to strengthen connections between managers of lands dedicated for conservation and private grassland livestock producers, so that conservation easements may be more widely accepted and implemented in the future when financial resources are more readily available.

References

Barrett, M.W. (1982) Distribution, Behavior, and Mortality of Pronghorns during a Severe Winter in Alberta. *Journal of Wildlife Management,* 46(4), 991-1002.

Derner, J.D., W.K. Lauenroth, P. Stapp, and D.J. Augustine. (2009) Livestock as Ecosystem Engineers for Grassland Bird Habitat in the Western Great Plains of North America. *Rangeland Ecology and Management,* **62**,111–118

General Accountability Office. (2007a) Agricultural Conservation Farm Program Payments Are an Important Factor in Landowners' Decisions to Convert Grassland to Cropland. GAO Report 07-1054.

General Accountability Office. (2007b) At the Current Pace of Acquisitions, the U.S. Fish and Wildlife Service Is Unlikely to Achieve Its Habitat Protection Goals for Migratory Birds . GAO Report 07-1093.

Hoekstra, J.M., T.M. Boucher, T.H. Ricketts, and C. Roberts. (2005) Confronting a biome crisis: global disparities of habitat loss and protection. *Ecology Letters,* **8,** 23–29.

Knopf, F.L. (1996) Prairie legacies - birds. *Prairie Conservation: Preserving North America's Most Endangered Ecosystem* (F. B. Samson and F. L. Knopf, eds.), pp. 135-148. Island Press, Washington, D.C.

Martinka, C.J. (1967) Mortality of Northern Montana Pronghorns during a Severe Winter. *Journal of Wildlife Management,* **31**(1), 159-164.

Rashford, B.S., J.A. Walker, and C.T. Bastian. (2011) Economics of Grassland Conversion to Cropland in the Prairie Pothole Region. *Journal of Conservation Biology,* **25** (2), 276-284.

Saab, V.A., C.E. Bock, T.D. Rich, and D.S. Dobkin. (1995) Livestock grazing effects in western North America. *Ecology and Management of Neotropical Migratory Birds: a Synthesis and Review of Critical Issues.* (T.E. Martin and D.M. Finch, eds.), pp. 311–353.New York, NY, USA: Oxford University Press.

Stephens, S.E., J.A. Walker, D.R. Blunck, A. Jayaraman, D.E. Naugle, J.K. Ringleman, A.J. Smith. (2008) Predicting Risk of Habitat Conversion in Native Temperate Grasslands. *Conservation Biology,* **22**, 1320-1330.

Stevens, B.S., K.P. Reese, and J.W. Connelly. (2010) Impacts of Fences on Greater Sage-grouse in Idaho: Collision, Mitigation, and Spatial Ecology. Thesis Research Report. University of Idaho, Moscow.

Conservation grazing in Grasslands National Park, Saskatchewan, Canada

Presenter: Nicola Koper

Co-Author: Pat Fargey, Grasslands National Park of Canada

Initial policies of livestock removal from the lands that now make up Grasslands National Park of Canada (GNPC), which started in the 1980s, have since come to be seen as counterproductive. Absence of grazing ungulates and suppression of native wildfires seem to have led to increased homogeneity of the vegetation structure and declines in population of species that benefit from habitat disturbance, such as McCown's longspurs. To address these concerns, GNPC has altered its land management practices to reintroduce grazing ungulates, and to a lesser extent fire, into the park. We will discuss the process and ecological consequences of (1) introducing a small herd of plains bison to the west block of the park, (2) active adaptive management of cattle at a range of stocking rates in the east block of the park, (3) interactions between ungulate grazing and native wildfires, and (4) low-impact management methods that have been implemented to reduce effects of livestock management on the national park. Low-impact livestock management has been surprisingly inexpensive and practical, potentially providing ecologically beneficial solutions to animal management for both conservation grazing and commercial ranching. Ecological impacts of reintroducing ungulates have been subtle but significant and are likely to grow over time. Effects of stocking rates have generally been nonlinear, with many effects on vegetation and avian communities increasing after a threshold detected at moderate grazing intensities. With a few exceptions, effects of bison and cattle have been ecologically similar, suggesting that cattle may be a practical and effective substitute when native ungulates cannot be reintroduced. Fire and grazing have qualitatively similar but additive effects on vegetation structure and grassland songbird communities. Both natural and anthropogenic disturbances have been important for restoring ecological integrity to the park, and must be maintained or increased in the following years.

Grasslands Management in Badlands National Park

Presenter: Milton Haar, Badlands National Park (Milton_Haar@nps.gov)

In this presentation, goals, challenges and strategies for managing grassland in a national park were explored. Famous for sharply eroded buttes, pinnacles, spires, and grassland, Badlands National Park is a refuge for bison, bighorn sheep, pronghorn, prairie dogs, black-footed ferrets, and many species of birds, reptiles, amphibians, and insects, some of them threatened or endangered. Set aside from agriculture and development, park grassland is a remnant of a once vast, mixed-grass prairie. The goal for managers is preservation of the natural resources and natural processes of the mixed-grass prairie ecosystem, using the pre-settlement vegetation and ecosystem as the reference condition. Conditions are currently less than ideal, and active management is required. Among the challenges facing resource managers are recovery from past grazing and agricultural damage, exotic and invasive plants, invasive wildlife pests and diseases, climate change, and the impact of one million visitors every year. To meet these challenges park managers employ an integrated strategy that focuses on long term goals and includes public education, cooperation with neighboring land owners, and research. As more knowledge about grassland ecosystems and how they function is gained through research, park managers are better able to make decisions that ensure the long-term health and preservation of park grassland.

Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie

Presenter: W.R. Teague, Texas AgriLife Research, Texas A&M University (r-teague@tamu.edu)

Other Authors: S. L. Dowhower, S. A. Baker, P. B. DeLaune, and D. M. Conover, Texas AgriLife Research; N. Haile , Natural Resource Conservation Service.

To assess whether adaptive management using multi-paddock grazing is superior to continuous grazing regarding conservation and restoration of resources and ecosystem goods and services we evaluated the impact of multi-paddock (MP) grazing at a high stocking rate compared to light continuous (LC) and heavy continuous (HC) grazing on neighboring commercial ranches in each of 3 proximate counties in north Texas tall grass prairie. The same management had been conducted on all ranches for at least the previous 9 years. Impact on soils and vegetation was compared to ungrazed areas (EX) in 2 of the counties. MP grazing was managed using light to moderate defoliation during the growing season followed by adequate recovery before regrazing after approximately 40 days and 80 days during fast and slow growing conditions, respectively.

The vegetation was dominated by high seral grasses with MP grazing and EX, and dominated by short grasses and forbs with HC grazing. LC grazing had a lower proportion of high seral grasses than MP grazing or EX. Bare ground was higher on HC than LC, MP and EX, while soil aggregate stability was higher with MP than HC grazing but not LC grazing and EX. Soil penetration resistance was lowest with MP grazing and EX and highest with HC grazing. Bulk density did not differ among grazing management categories. Infiltration rate did not differ among grazing management categories but sediment loss was higher with HC than the other grazing management categories.

Soil organic matter and cation exchange capacity were higher with MP grazing and EX than both LC and HC grazing. The fungal/bacterial ratio was highest with MP grazing indicating superior water holding capacity and nutrient availability and retention for MP grazing.

This study documents the positive results for long-term maintenance of resources and economic viability by ranchers who use adaptive management and MP grazing relative to those who practice continuous season-long stocking.

Full article reference

Teague, W.R., Dowhower, S.L., Baker, S.A, Haile, N., DeLaune, P.B, Conover, D.M. (2011) Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie. *Agriculture Ecosystems and Environment* **141**, 310-22.

Grazing management effects on the plant community in mixed-grass prairie within the Missouri Coteau region

Presenter: Guojie Wang, North Dakota State University (Guojie.Wang@ndsu.edu)

Other Authors: Kevin Sedivec, Paul E. Nyren, Bob D. Patton, and Anne Nyren, North Dakota State University

Plant community cover, density, composition, diversity, and productivity were examined to investigate the long-term effects of different livestock grazing management on plant community properties. The four grazing management treatments studied (season-long extreme grazing [EG], season-long moderate grazing [MG], twice-over rotational grazing [RG], and idle [ID]) at the landscape level (summit, backslope, and toeslope) have been imposed on mixed-grass prairie within the Missouri Coteau Region near Streeter, North Dakota (ND), for more than 20 years.

The EG decreased the litter cover and increased bare ground on the backslope, while the ID increased live plant basal cover and the MG increased forb and shrub cover on the summit. The ID had the highest foliar cover, followed by the RG, MG, and EG. However, after one year protection from grazing, the differences were no longer significant.

Grazing management changed plant community species composition and their abundances. The EG increased forb density compared with the ID on the backslope. The EG and MG increased species richness by increasing forb species richness and enhanced species evenness compared with the RG and ID. Shannon diversity index of the MG and EG was greater than the ID and RG. The EG and MG decreased litter and live plant biomass. The ID and RG had higher aboveground net primary productivity (ANPP) than the EG on the toeslope.

The toeslope had higher litter cover and lower live plant basal cover than the summit and higher foliar cover than the summit and backslope. Topography did not impact plant community species composition and diversity. However, the toeslope had higher litter biomass than the summit and higher live plant biomass than the summit and backslope. The toeslope had the highest ANPP, followed by the backslope and summit.

Live plant basal cover and foliar cover had a positive correlation with productivity. Bare ground and forb density had a positive correlation with diversity. Diversity had a negative correlation with productivity.

Grazing management effects on the plant community properties depend on the landscape position and the evaluated parameter. Grazing management changed biomass and ANPP by at least changing biotic factors, and topography changed biomass and ANPP by changing mainly abiotic factors.

Poster Presentations

Pox seroprevalence and missing digits in the Henslow's Sparrow

Presenter: Kevin Ellison, Wildlife Conservation Society (kellison@wcs.org)

Other Authors: E. K. Hofmeister, USGS National Wildlife Health Center, Madison, WI; C. A. Ribic, US Geological Survey Wisconsin Cooperative Wildlife Research Unit, Madison, WI; D. W. Sample, Wisconsin Department of Natural Resources, WI.

The Henslow's Sparrow *(Ammodramus henslowii)* breeds in tallgrass prairie and is a focal species for grassland management largely due to its long-term decline. Recent positive population responses to grasslands created through the USDA's Conservation Reserve Program are encouraging. However, the identification of factors affecting Henslow's Sparrow populations remains a high conservation priority. During April-July, 2005-2008, we captured 346 individuals of nine bird species common to grasslands in Wisconsin. All birds captured were inspected visually for abnormalities. We found that the Henslow's Sparrow had the highest incidence of missing footparts: 16 of 165 (9.7%) ranging from missing a single phalanx to up to three complete digits. Similarly, Henslow's Sparrow had the highest incidence of lesions (6.1%). In 2008, we obtained blood samples from 26 Henslow's Sparrows. Among the subset blood-sampled, active lesions, such as dry crusted areas of the featherless portions of the body, swollen digits and/or missing digits were recorded for 8 (30.7%) Henslow's Sparrows, 3 (11.5%) of which had both lesions and missing digits. Serological tests with canary and fowl pox viruses found that 3 of 9 (33%) symptomatic birds were sero-positive for canary pox. We stress the need for further studies of disease and survivorship impacts among grassland birds and identification of where and when, seasonally, pox virus is acquired.

Credit: Bob Dayton, NRCS.

"Livestock graze the majority of rangelands globally, contributing $74 billion in business to many rural economies and forming a major component of U.S. agricultural production"

–Kennedy, P.L. Responses of a Pacific Northwest Bunchgrass Food Web to Experimental Manipulations of Stocking Rate (page 17).

Development of a fire science network and delivery system for the Northern Tallgrass Prairie, Central Tallgrass Prairie, Prairie Forest Border, and North Central Till Plain Ecoregions of the Upper Midwest U.S.

Presenter: Amy Alstad, Eastern Tallgrass Prairie and Oak Savanna Fire Science Consortium

Other Authors: Paul Zedler, John Harrington, Christine Ribic - University of Wisconsin, Madison; Hannah Spaul, The Nature Conservancy; Jessica Miesel, Ohio State University; Richard Henderson, Wisconsin Department of Natural Resources; Paul Charland, US Fish & Wildlife Service

Despite general recognition of the importance of fire to native prairies and savannas of the Upper Midwest, significant impediments exist to using fire as widely and effectively as possible. Fire science information development and exchange is limited, and the practical knowledge possessed by skilled practitioners is inaccessible to others. We proposed an Eastern Tallgrass Prairie and Oak Savanna Fire Science Consortium to identify existing fire science networks and delivery capabilities in the region, and to enhance the communication and evaluation of fire science information beyond current capabilities. The consortium will tap the collective knowledge of the practitioner community to improve fire management practices while also building a network of managers, policy-makers, scientists, and other stakeholders. This network will identify knowledge gaps and provide information that informs policy decisions at all levels. Proposed consortium activities include surveys, a fire needs assessment, establishment of demonstration sites, workshops and meetings, a seed grant program, and an online knowledge bank. Specifically, the consortium will (1) facilitate improved information exchange among fire practitioners to identify regional fire science needs, (2) develop a framework for evaluating fire management practices, and (3) develop a network by which fire science information will be accumulated, synthesized, and disseminated. The primary beneficiaries of our enhanced fire science delivery and outreach activities will be those land managers that actively utilize fire for restoration and management of tallgrass prairie and savanna ecosystems, including federal, state, and local governments, NGOs, restoration contractors, and private landowners. The Northern Tall Grass Prairie, Central Tall Grass Prairie, Prairie Forest Border, and North Central Till Plain ecoregions broadly share similar climatic and cultural attributes. We utilized ecological criteria to delineate this geographic region, and the consortium therefore extends across state boundaries. We will focus our efforts on developing partnerships with land management organizations in southern Wisconsin, Minnesota, and Michigan, northern Illinois and Missouri, and Iowa, and will welcome participation from relevant entities from other states within the selected ecoregions. The University of Wisconsin-Madison's (UW) Nelson Institute for Environmental Studies will serve as the institutional home for the proposed consortium.

Bison mediated seed dispersal in a tallgrass prairie reconstruction

Presenter: Peter G. Eyheralde, Iowa State University (pete@iastate.edu)

Other authors: Emily J. Artz and W. Sue Fairbanks, Iowa State University

Animal-mediated seed dispersal may be a critical ecological process, eliminated by the removal of key animal species from ecosystems. Due to grazing activities, bison have been considered keystone species in the evolution of North American prairies, but bison also have great potential to be effective seed dispersers. This study was initiated to determine the degree to which bison play a role as dispersal agents in a tallgrass prairie reconstruction. As part of a larger study, we addressed the role of bison in non-native and native seed dispersal via shed hair at Neal Smith National Wildlife Refuge in southern Iowa. In this poster we report the seed composition in shed bison hair, as well as in hair clipped from the bison at the end of the growing season. We hypothesized that seed species composition would differ by season, by age-sex class of bison, and location on the body. Thirty five samples of shed bison hair were collected May-July 2007. We clipped bison hair samples from the head and/or body of 8 bulls, 10 cows and 29 juveniles in November 2010. Seeds were identified to species or genus, classified as native or non-native, by size, and by diaspore characteristics. Naturally shed bison hair contained significantly more native species than non-native species. Preliminary results suggest a higher percentage of forbs in hair samples clipped from the bison in fall compared to hair shed naturally in summer. Seed species composition differed in hair samples collected from calves, yearlings, cows, and bulls, based on preliminary evidence. In addition, the ratio of grass to forb seeds appeared to differ in samples clipped from the head and body. Numerous species found in bison hair showed specialized appendages for wind dispersal rather that adhesive dispersal. Differences in dispersal of native versus non native species in shed hair may be due to habitat selection, diet, or composition of plant communities in the ongoing reconstruction. A diverse mix of native and non-native seeds were found in shed bison hair and attached to the animals, suggesting that bison are potential dispersers of both forbs and grasses.

Utilizing Fire, Nitrogen, and Herbicide to Increase Warm-Season Biomass

Presenter: Shauna Waughtel, South Dakota State University (shauna.waughtel@sdstate.edu)

Other Authors: S.A. Clay, A. Smart, D.E. Clay, and L.C. Schleicher, South Dakota State University

Eastern South Dakota prairie remnants are our glimpses of historical tallgrass prairie that once covered about 206 million acres of the United States. These remnants continue to be threatened due to the loss of natural disturbances, land development, and the intentional or accidental introduction of exotic species. Introduced grass species utilize nutrient resources and crowd out native root systems creating unfavorable conditions for native species. This study used spring burns, glyphosate applied late fall or early spring, and nitrogen applied early spring, early summer, or fall to stimulate native species [big bluestem (Andropogon gerardii) and sideoats grama (Bouteloua curtipendula)] and decrease non-native species [smooth brome (Bromus inermis) and Kentucky bluegrass (Poa pratensis)] biomass. Treatments were applied at two sites (Artesian and Volga) in Oct 2009 and April/May/June 2010 in replicate trails. Biomass was collected at the peak of cool-season non-native (June, 2010) and warm-season native (August 2010) grass growth to evaluate results when compared with the control. Warm-season biomass, compared with untreated control areas, had a minimum of 30% increase with all fire plots. Compared with the control, warm-season grass biomass increased 41% with June N application at Artesian and 77% with double N application (Oct and April) at Volga. At Artesian, warm-season biomass was >100% compared with the control with the April N followed by May herbicide treatment. May herbicide with June N had 75% warm-season biomass increase at Volga. In summer 2011, a second year of study will follow previously established treatments and also replicate treatments from year 1.

Impacts of potential herbaceous bioenergy crops on wildlife: grassland bird use across a diversity gradient of native warm season grass fields in southwestern Wisconsin

Presenter: Carolyn Schmitz, Department of Forest and Wildlife Ecology, University of Wisconsin-Madison, (cmschmitz2@wisc.edu)

Other Authors: John Dadisman, David W. Sample - Wisconsin Department of Natural Resources; Christine A. Ribic, US Geological Survey Wisconsin Cooperative Wildlife Research Unit; and Daniel Schneider, University of Wisconsin-Madison

Mandates and incentives for deriving energy from renewable sources, including dedicated biomass crops, will result in substantial changes in land cover in the fuel-sheds surrounding bioenergy plants. The types and amount of bioenergy crops produced will impact habitat availability and quality for declining populations of grassland birds. Native warm season grasses are likely bioenergy feedstocks. The objectives of this study are to determine the grassland bird community and nesting productivity in native warm season grass fields in Wisconsin. We used 12 fields (7-25 ha) in southwestern Wisconsin, most currently enrolled in the Conservation Reserve Program, that spanned a continuum of low plant diversity sites (e.g., monotypic switchgrass) to high plant diversity sites (prairie restorations). In May-July 2009 and 2010, we used spot mapping to determine the bird community. We found nests by rope dragging, systematic walking, and using behavioral observations. Nests were monitored every two-three days. We placed video cameras at a subset of nests to identify nest predators. Nine obligate grassland bird species occurred in the study sites; average species richness for grassland obligates per site was 6.2 (standard error = 0.5). We found 146 nests of obligate grassland bird species. Nest predators included snakes (fox and milk), striped skunk, fox, badger, raccoon, opossum, 13-lined ground squirrel, mice, ants, and weasels. Work will continue in 2011. This information can be used with other extant data to assess the impacts of different mixes of native warm season grass habitats on grassland bird populations.

Restoring Native Tallgrass Prairie and Improving Profitability on Eastern South Dakota Grasslands with Intensive Early Stocking

Presenter: Kyle Schell, South Dakota State University (kyle.schell@sdstate.edu)

Other Authors: Eric Mousel, Millborn Seeds; Alexander Smart, South Dakota State University

Season-long grazing by livestock has converted the majority of remaining native grassland in eastern South Dakota to a mix of introduced species such as smooth bromegrass *(Bromus inermus,* Leyss.) and Kentucky bluegrass *(Poa pratensis*) (Mousel and Smart, 2007). Additionally, the financial incentives for ranchers to adjust season-long grazing practices are few. The EQIP program offered through the USDA/NRCS has provided some incentives for producers to manage forage more efficiently through the implementation of rotational grazing systems, however, rotational systems generally are season long systems and typically do not substantially reduce grazing pressure on warm-season grasses during critical times for growth and development in mid- to late-summer.

Financially, cow-calf producers are currently being squeezed by cattle feeders that are reluctant to buy lightweight calves in the face of escalating corn and supplemental feed costs driving the market value of both stocker and feeder cattle down. This scenario is enticing ranchers to hold on to weaned calves longer to add more weight by overwintering them and turning them out on grass the following summer to take advantage of the low cost gain associated with lightweight cattle on grass to improve profit margins. Unfortunately, grazing growing cattle on predominately cool-season grasses for the entire summer is not a terribly efficient production system. Once cool-season species mature and senesce by early- to mid-summer, gains on growing cattle generally decrease dramatically, resulting in marginal net gains.

Intensive early stocking systems (IES), however, potentially could address both of these issues by improving the growth efficiency and thus profitability of lightweight cattle as a result of matching intake demand to available forage in the early-season. Moreover, the very nature of the IES system lends itself to being a tool to begin the restoration process of native tallgrass ecosystems by concentrating grazing pressure on the introduced cool-season forage species during critical stages of growth and development and removing grazing pressure at the most critical stages of growth and development for native warm-season species resulting in a system that can develop and sustain the integrity and environmental quality of the natural resource base and improve the profitability of producers.

In 2010, two test plots were developed, one located at SDSU's Cow Camp Research Station south of Miller, SD and the other at SDSU's Cow-Calf Unit north of Volga, SD. At the Miller location, a 24.28 ha pasture was split into two 12.14 ha paddocks, with an IES trial on one and a SL trial on the other. The Volga location consisted of two side-by-side 8.09 ha paddocks, with an IES trial on one and a SL trial on the other. All of the trials were stocked with feeder steers weighing approximately 317.5 kg. The grazing period for the IES was 60 days and the SL was 120 days at both locations. Cattle were stocked at 2.87 AUM ha^{-1} at the Miller, SD location and 3.25 AUM ha^{-1} at the Volga, SD location.

Average daily gain (ADG) and gain per acre were calculated at the end of the trial for each treatment at each site. Above ground biomass was determined on all paddocks at turnout and then approximately every 30 days until the trials ended. Biomass was collected using a drop disc and clipping 10 samples to develop regression equations. The clipped samples were then analyzed in the lab with NIRS to determine crude protein content.

Species composition was determined by visual estimation of ten 0.25m^2 quadrates taken from a predetermined 15 m^2 location. Three 15m^2 locations were located in each paddock. Percent species composition of native warm-season grasses, native cool-season grasses, introduced cool-season grasses, native forbs, introduced forbs, and litter were determined.

Average daily gain and gain per acre did not differ between the IES and season-long continuous treatments (Figure 16 & 17). Anderson et al. (1970) reported that steer gains during the latter half of the growing season on Kansas Flint Hills range were barely one-half those of the first half of the season because forage quality declines with grass maturation and translocation of nutrients to reserve pools. Our data suggests that forage quality, measured as crude protein content, of smooth bromegrass and Kentucky bluegrass does not decline as dramatically in the second

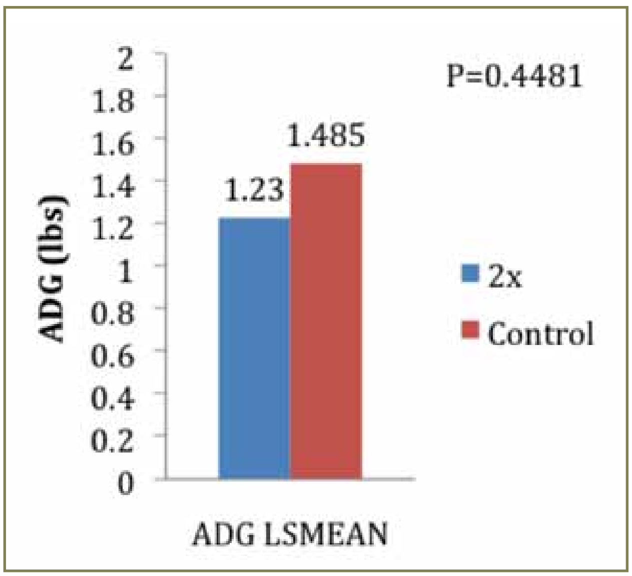


Figure 16

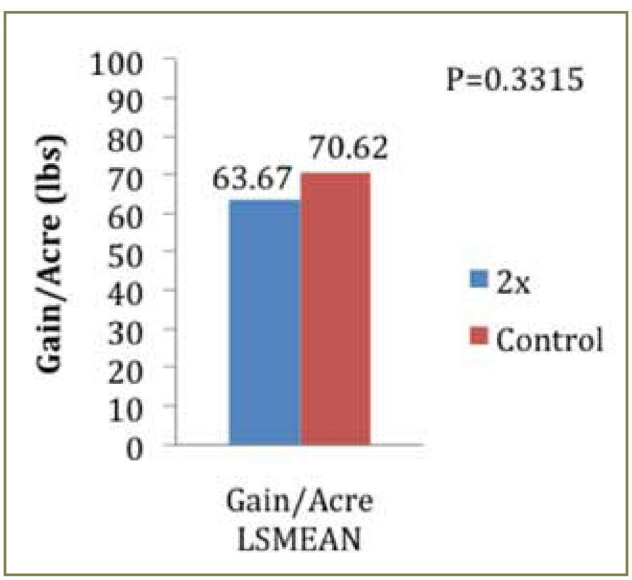


Figure 17

half of the grazing season as it does with warm-season talllgrasses. Furthermore, both locations experienced above normal precipitation during the experiment which may have lead to above normal levels of plant growth and crude protein content.

Although the analysis of species composition was not significant, a trend appears to be developing for more native warm-season grasses with the IES treatment (Figure 18). This indicates that IES could potentially be a way to restore grasslands in the tallgrass prairie region of the Northern Great Plains. A second field season is planned for this study at the same locations.

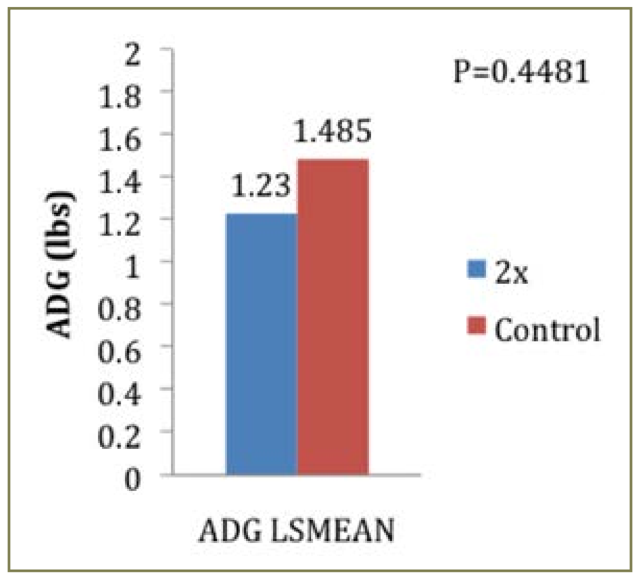


Figure 18

The effect of grazing intensity on grassland and cattle performance in south-central North Dakota

Presenter: Bob Patton, North Dakota State University (bob.patton@ndsu.edu)

Other Authors: Paul Nyren and Anne Nyren, North Dakota State University

A long-term grazing intensity study began at CGREC in 1989 to determine the ecological and economic effects of season-long cattle grazing at different intensities. Five treatments - no grazing, light, moderate, heavy, and extreme grazing - are each replicated three times. Pastures are approximately 30 acres each. The no grazing treatment consists of six 0.3-acre exclosures. Pastures are stocked so that when the cattle are removed in the fall, about 65, 50, 35, and 20% of the forage produced in an average year remains on the light, moderate, heavy, and extreme grazing treatments, respectively.

The two most common ecological sites, loamy and loamy overflow, are monitored. Forage production on the loamy site is highest under the light grazing treatment. On the loamy overflow site, production does not differ between light, moderate, and heavy, but ungrazed and extreme treatments produce significantly less forage.

A total of 164 species have been found on the loamy sites and 62 have shown a response to grazing based on frequency, density, or basal cover. Of the 172 species on the loamy overflow sites, 53 have responded to grazing. These responses include increasing or decreasing with increased grazing pressure, benefiting from moderate grazing, or invading (only appearing after heavy grazing). Of the species responding to grazing (30-40% of the total), the majority are favored by a moderate or heavy level of grazing.

Since 1990, average daily gain and animal body condition scores have decreased with increasing grazing intensity. Initially, gain/ton of available forage increases as the stocking rate increases, but then declines at higher stocking rates.

We cannot predict which stocking rate will give the maximum gain/ton of forage in a particular year. However, at 2.39 AUM/ton of available forage, gain/ton from 1991-2010 would have averaged 75.7 lbs/ton. If cattle prices were consistent, then return/ton would peak at a stocking rate somewhere below maximum gain/ton, with the exact point depending on carrying costs. The change in cattle prices over the season determines the stocking rate with the maximum return/ton. The stocking rate with the maximum return/ton over the last 20 years would be 1.74 AUM/ton, with an average annual return of $28.24/ton.

Forage Production

On the loamy ecological site, the greatest forage production is on the light treatment.

On the loamy overflow ecological site, forage production does not differ between the light, moderate, and heavy treatments, but ungrazed and extreme produce significantly less forage.

Plant Community Dynamics

Loamy Sites

Of the 164 plant species on loamy ecological sites, 62 have shown a response to grazing (listed in order of dominance).

Species that decrease under grazing:
Poa pratensis - Kentucky bluegrass
Lotus purshianus - deer vetch
Helianthus pauciflorus - stiff sunflower
Artemisia absinthium - wormwood
Psoralea esculenta - breadroot scurf-pea
Some species favored by moderate grazing:
Artemisia ludoviciana - cudweed sagewort
Oligoneuron rigidum - stiff goldenrod
Stipa curtiseta - western porcupine grass
Cirsium flodmanii - Flodman's thistle
Ratibida columnifera - prairie coneflower
Bromus inermis - smooth brome
Some species that increase under grazing:
Pascopyrum smithii - western wheatgrass
Carex inops ssp. *heliophila* - sun sedge
Nassella viridula - green needlegrass
Achillea millefolium - western yarrow
Bouteloua gracilis - blue grama
Taraxacum officinale - common dandelion
Artemisia frigida - fringed sagewort
Species that appear only after heavy grazing:
Agrostis hyemalis - ticklegrass
Medicago lupulina - black medic
Juncus interior - inland rush
Polygonum ramosissimum - bushy knotweed
Trifolium repens - white clover

Loamy Overflow Sites: Of the 172 plant species on loamy overflow ecological sites, 53 have shown a response to grazing.

Species that decrease under grazing:
Symphoricarpos occidentalis – buckbrush
Bromus inermis - smooth brome
Helianthus pauciflorus - stiff sunflower
Rosa arkansana - prairie rose
Liatris ligulistylis - round-headed blazing star
Some species favored by moderate grazing:
Oligoneuron rigidum - stiff goldenrod
Ambrosia psilostachya - western ragweed
Solidago canadensis - Canada goldenrod
Glycyrrhiza lepidota - wild licorice
Solidago mollis - soft goldenrod
Carex lanuginosa - wooly sedge
Some species that increase under grazing:
Poa pratensis - Kentucky bluegrass
Symphyotrichum ericoides - heath aster
Artemisia ludoviciana - cudweed sagewort
Achillea millefolium - western yarrow
Carex inops ssp. *heliophila* - sun sedge
Taraxacum officinale - common dandelion
Species that appear only after heavy grazing:
Medicago lupulina - black medic
Trifolium repens - white clover
Polygonum ramosissimum - bushy knotweed
Lithospermum incisum - yellow puccoon
Lepidium densiflorum - peppergrass

Livestock Response

Average daily gain and condition scores decrease as grazing intensity increases. Gain per ton of forage initially goes up as grazing intensity increases, but there is a point beyond which gain per ton decreases with increasing grazing intensity.

Economics

If cattle prices were constant, then return/ton would peak at a stocking rate somewhere below maximum gain/ton, with the exact point depending on carrying costs. The change in cattle prices over the season determines the stocking rate with the maximum return/ton. The stocking rate with the maximum return/ton over the last 20 years would be 1.74 AUM/ton, with an average annual return of $28.24/ton.

Conclusions

After 21 years, this study has demonstrated that:

- Biomass production is greatest with a light or moderate stocking rate.
- Plant species diversity is lowest under no grazing and increases with grazing intensity, although many of the species that increase under extreme grazing are weedy or invasive.
- Individual animal daily gains and condition scores decrease with increasing grazing intensity.
- Gain per ton of available forage peaks at around 2.39 AUM/ton of forage.
- Economic return peaks at around 1.74 AUM/ton of forage.

For more information, visit the CGREC website: www.ag.ndsu.edu/CentralGrasslandsREC/

Effects of grazing intensity on plant biodiversity and vegetation structure in a northern mixed-grass prairie

Presenter: Tonya Lwiwski, University of Manitoba (tonya_lwiwski@hotmail.com)

Co-author: Dr. Nicola Koper, University of Manitoba

In the Great Plains of North America, grazing is considered a keystone process. Currently, livestock management practices on these rangelands strive for even use of forage, which create a homogenous landscape. It has been recognized that many grassland species have different habitat requirements and consequently maintaining a heterogeneous landscape is imperative to conserve biodiversity. Grasslands National Park, located in the northern mixed-grass prairie of southern Saskatchewan, Canada, implemented a long-term study to assess the effects of grazing intensity of cattle on vegetation and habitat heterogeneity. Plant species diversity and habitat structure were assessed in nine pastures, each of approximately 300 ha. Three of these pastures were selected as controls and had no grazing, and six were grazed at a range of grazing intensities (stocking rates) from very low to very high intensities for this region (AUM of 0.23 to 0.83, approximately 20 to 70% utilization). Three years of post-grazing data have been collected to date. Generalized linear mixed models (GLMMs) were used to evaluate effects of year, grazing intensity (AUMs/ha) and the interaction of grazing intensity × year. The random variable was pasture, to statistically control for the fact that plots were clustered within pastures. Preliminary results suggest that the effects of grazing are cumulative and increase over time. Plant species richness and diversity increased as grazing intensity increased. Conversely, habitat heterogeneity decreased as grazing intensity increased. All effects became more pronounced over time. To maximize overall biodiversity, the use of a variety of grazing intensities is suggested to maximize heterogeneity at the landscape level, while still allowing for increased plant diversity at elevated grazing intensities.

The relative effects of grazing by bison and cattle on plant community heterogeneity in northern mixed prairie

Presenter: Adrienne Tastad, University of Manitoba (umtastad@cc.umanitoba.ca)

Other Authors: Nicola Koper, Natural Resources Institute, University of Manitoba

Because of the keystone role that bison grazing played during the evolution of central North American grasslands, grazing by domestic cattle is sometimes considered to be a useful tool to promote taxonomic and patch diversity. However, there is no agreement within the literature as to whether cattle can function as ecological equivalents to bison in a conservation context. Each herbivore exhibits different selective grazing behaviors at multiple scales, but it is unclear whether the sum of selective behaviors results in different impacts on ecosystem processes and biodiversity. This study examined the influence of bison and cattle grazing at different intensities on plant communities in Grasslands National Park in southern Saskatchewan. The relative influence of each herbivore on floristic diversity, plant community composition and structure, and spatial heterogeneity was measured using Modified Whittaker sampling plots. Grazing intensity was quantified based on the number of dung pats present in each plot. Responses of the plant community to grazing intensity, and the interaction between grazing intensity and species of grazer, were analyzed using mixed-effects models. Preliminary results indicate that cattle and bison have had similar (but not identical) effects on plant community composition and structure after three and five years of grazing, respectively. Under both herbivores, the forb component increased with grazing intensity, while vegetation height-density and litter decreased. Floristic diversity, measured using two diversity indices (D, H'), varied significantly based on the interaction of grazing intensity and species of grazer, which may suggest either that the two herbivores have had different impacts on plant community diversity, or that there are inherent differences between plots grazed by bison and plots grazed by cattle. Bison grazed at the highest intensities in relatively homogenous areas that were low in species diversity, which aligns with literature that suggests bison have a selective preference for grass-dominated patches, whereas cattle seek out heterogeneous areas in which to graze (Plumb and Dodd 1993). Grazing by both herbivores has the potential to modify biodiversity over time, both via species replacement (i.e., enhanced recruitment of the forb component into the plant community), and via their relative impacts on spatial heterogeneity. Increases in heterogeneity can sometimes lead to increases in biodiversity, and also have important implications for habitat diversity, and other ecosystem processes (Adler et al. 2001). The next phase of this study will examine the spatial pattern of grazing by each herbivore using spatially explicit statistics. By quantifying the relative effects of these two herbivores on large, complex landscapes, this study will inform future management efforts aimed at conservation of prairie habitat using bison or cattle to mimic natural historic disturbance.

References

Adler, P.B., Raff, D.A. & Lauenroth, W.K. (2001) The effect of grazing on the spatial heterogeneity of vegetation. *Oecologia*, **128**, 465-479.

Plumb, G.E., & Dodd, J.L. (1993) Foraging ecology of bison and cattle on mixed prairie: implications for natural area management. *Ecological Applications*, **3,** 631-643.

BLM grasslands in Montana. Credit Steve Zack, Wildlife Conservation Society.

Monitoring the Effects of Patch-Burn Grazing on the Plant Species Composition of High Diversity Prairie at Lac Qui Parle WMA and Chippewa Prairie Preserve, Minnesota

Presenter: Fred S. Harris, Minnesota DNR County Biological Survey (fred.harris@state.mn.us)

Other Authors: Diane L. Larson, USGS Northern Prairie Wildlife Research Center; Marissa Ahlering, The Nature Conservancy

In 2012, The Nature Conservancy and the Minnesota Department of Natural Resources plan to begin jointly managing a 2,700 acre prairie in western Minnesota with patch-burn grazing (PBG) on five burn units (Figure 19). The goal is to improve habitat structure for wildlife, help control specific invasive plants, and maintain high diversity ("high quality") prairie. Eighty percent of the prairie has been managed with periodic controlled burns and no grazing for several decades. Smooth brome and sweet clover have invaded much of the prairie, but large portions of the prairie still have high native plant diversity and abundant conservative plant species.

To isolate the effects of grazing from other variables (climate, management, etc.) we chose to compare paired plots of ungrazed prairie in exclosures with grazed prairie. We will examine the effects of PBG on the plant species composition of high quality mesic prairie in four burn units, and on disturbed prairie in the fifth unit.

In 2010, we sampled three pairs of 10m x 10m sample plots in each burn unit to test the statistical power of different sample sizes. Each plot was sampled for frequency and cover for all plant species in five 10m^2 subplots and 17 nested 0.1m^2 and 1m^2 subplots. Using repeated measures

ANOVA with pairs of plots as blocks and management unit as a fixed effect, Deb Buhl, USGS statistician, created a simulation to estimate effects of different sample sizes on statistical power using the means and variances recorded in 2010. Statistical power analyses of these data for sixteen focus species (conservative plant species, dominant grasses, and selected invasives) indicated that sample sizes of 3 to 5 repeatedly-sampled pairs of grazed and ungrazed sample sites in each management unit allow detection of changes of > 15% cover or >17.6% frequency due to treatment effects (grazing versus no grazing) with > 90% power, assuming the pre-treatment condition is sampled (Table 5). Much larger sample sizes would be needed to detect significant changes in plant species frequency and cover due to management unit or management unit – treatment interaction. We found that 10m^2 subplots were unnecessary because they did not capture additional plant species that were not already recorded in the nested 0.1m^2 and 1m^2 subplots.

In 2011, five permanent sample sites were randomly located within each burn unit with a minimum of 300m between each site. Each site's pair of 10 x 10m plots were sited a minimum of 15 m apart and plot treatment (grazed or ungrazed) was randomly assigned with a coin toss. The frequency and cover of all plant species in each plot was recorded in seventeen nested 0.1m2 and 1m2 subplots. Before grazing begins in 2012, 20m-diameter,

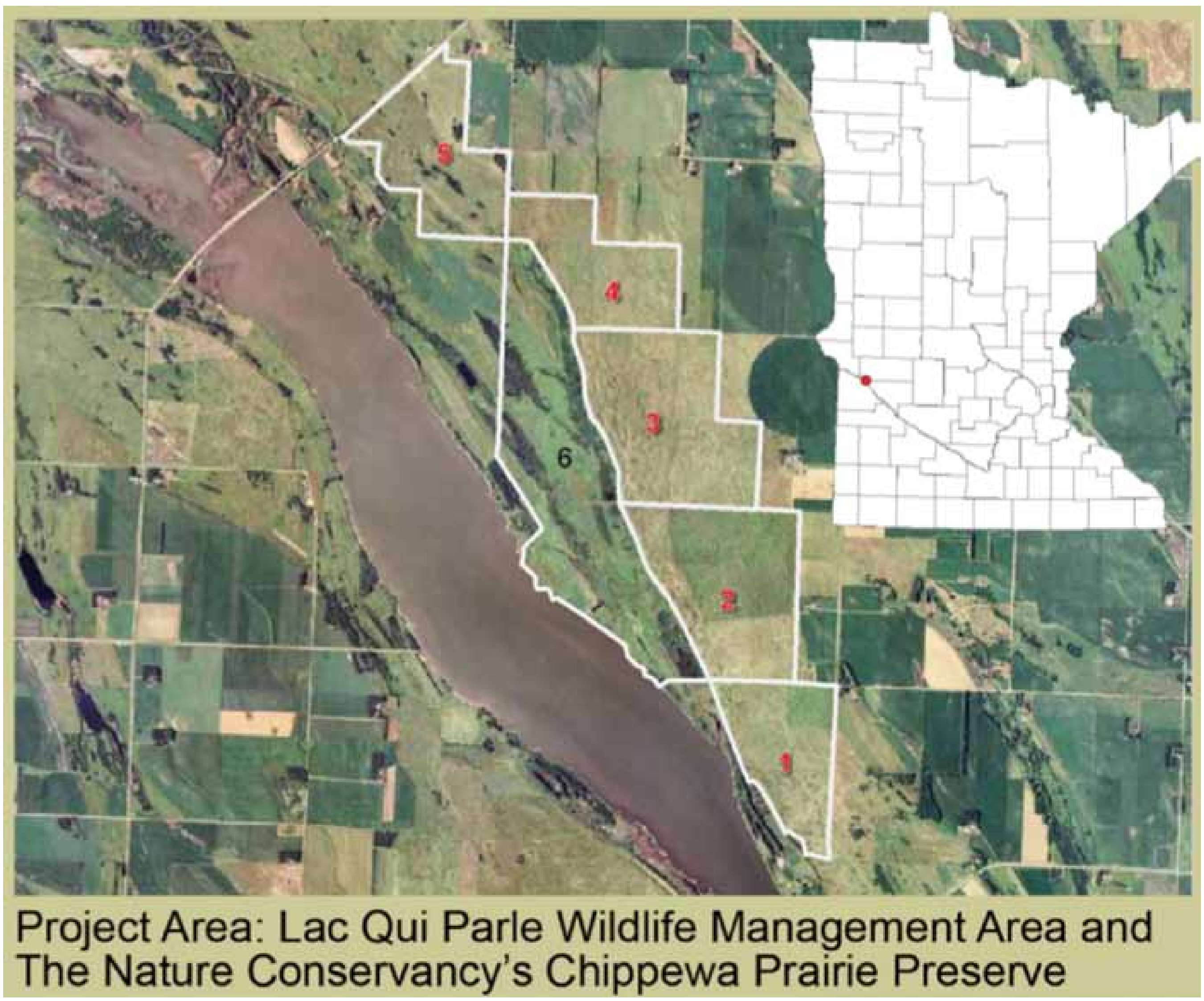


Figure 19.

Table 5.

Number of paired plots required for detection of change of 15 to 17.6% at > 90% power, given pre-treatment data

Species	Variable	N for power > 90%	Actual power	Effect size
Amorpha canescens	0.1 m² frequency	3	0.955	0.176
Amorpha canescens	1 m² frequency	7	0.929	0.176
Amorpha canescens	cover	3	0.999	0.15
Amorpha nana	0.1 m² frequency	3	1	0.15
Amorpha nana	1 m² frequency	3	1	0.176
Amorpha nana	cover	3	1	0.15
Andropogon gerardii	0.1 m² frequency	4	0.963	0.176
Andropogon gerardii	1 m² frequency	3	0.988	0.176
Andropogon gerardii	cover	3	0.965	0.15
Bromus inermis	0.1 m² frequency	10	0.913	0.176
Bromus inermis	1 m² frequency	> 12	0.804	0.176
Bromus inermis	cover	3	0.999	0.15
Dalea candida var. cand.	0.1 m² frequency	3	1	0.176
Dalea candida var. cand.	1 m² frequency	3	0.997	0.176
Dalea candida var. cand.	cover	3	1	0.15
Dalea purpurea	0.1 m2 frequency	3	1	0.176
Dalea purpurea	1 m² frequency	3	0.989	0.176
Dalea purpurea	cover	3	1	0.15
Dichanthelium leibergii	cover	3	1	0.15
Dichanthelium leibergii [1]	0.1 m² frequency	3		
Dichanthelium leibergii [1]	1 m² frequency	3		
Hesperostipa spartea	0.1 m² frequency	4	0.937	0.176
Hesperostipa spartea	cover	3	1	0.15
Liatris aspera	0.1 m² frequency	3	0.987	0.176
Liatris aspera	1 m² frequency	5	0.944	0.176
Liatris aspera	cover	3	1	0.15
Melilotus off/alb.	0.1 m² frequency	3	0.99	0.176
Melilotus off/alb.	1 m² frequency	4	0.955	0.176
Melilotus off/alb.	cover	3	1	0.15
Phlox pilosa	0.1 m² frequency	3	1	0.176
Phlox pilosa	1 m² frequency	3	1	0.176
Phlox pilosa	cover	3	1	0.15
Poa pratensis	0.1 m² frequency	3	1	0.176
Poa pratensis	cover	3	0.999	0.15
Schizachyrium scoparium	0.1 m² frequency	3	1	0.176
Schizachyrium scoparium	1 m² frequency	3	0.963	0.176
Schizachyrium scoparium	cover	3	1	0.15
Sporobolus heterolepis	0.1 m² frequency	3	0.982	0.176
Sporobolus heterolepis	1 m² frequency	5	0.906	0.176
Sporobolus heterolepis	cover	3	0.999	0.15
Symphyotrichum seric.	0.1 m² frequency	3	1	0.176
Symphyotrichum seric.	1 m² frequency	3	0.941	0.176
Zizia aptera	0.1 m² frequency	3	1	0.176
Zizia aptera	1 m² frequency	3	0.971	0.176
Zizia aptera [1]	cover	3		

[1] Correlation between years set to 0.8 for these estimates.

circular exclosures will be constructed of cattle panels around the ungrazed plots for each of the 25 plot pairs. We plan to sample the permanent plots every other year over two full patch-burn graze cycles, which would end in the year 2039 according to the current management plan.

Estimating the Probability of Prairie Restorations Outcomes in E. North Dakota and W. Minnesota

Presenters: Jack Norland, North Dakota State University (Jack.Norland@ndsu.edu) and Cami Dixon, USFWS

Other Authors: Tyler K. Larson, North Dakota State University and Kristine Askerooth, Tewaukon NWR

Prairie restorations have been implemented using a variety of seeding methods and techniques on United States Fish and Wildlife Service lands in Eastern North Dakota and Western Minnesota. A survey was initiated to determine the outcomes of these restorations and to provide guidance on what restoration methods and techniques produce desired results, and to be used as part of an adaptive management process. A total of 123 sites were sampled across the study area in various upland positions. Data collection took place during June, July, and August in 2009 and 2010. Information collected from the field and from restoration plans included plant community data, physical data, seed mixes, planting methods, planting age, and invasive/noxious weed info. Various sites were selected in a retracted randomized fashion where plant composition was sampled using ocular estimation of plant cover percent (%) within three 2m² quadrats placed in a triangular fashion 12 meters apart. The plant community data was analyzed with Non-metric Multi-dimensional Scaling (NMS) and cluster analysis combined with multi-response permutation procedures. From this analysis different groups were determined which were then used in correlation analysis to determine how the various physical, biotic, and management factors related to the groupings. Logistic regression analysis was use to determine how the various management factors effect on the probability of membership to the groups. It was found that prairie restorations in the study area can be placed into three significantly different groups (p>0.05). One group (Group 1) was made up of younger restorations that had high variability with the possibility of diverging into one of two other groups as time went on. One of the other two groups (Group 2) consists of older restorations, lacking in diversity and high in undesirable plant species. The last group (Group 3) had a variable age, moderate to high diversity, and low undesirable plant species and was thought to be most desired of the three groups. The logistic regression analysis found a high probability of membership to Group 3, greater than 8 out of ten restorations, when: 1) a minimum of 9 grass species were seeded, 2) ten forb species were included in the seed mix and , 3) at least 20 species were used in the seed mix. Dormant season seeding along with broadcast seeding were the most dependable planting techniques for membership to Group 3. This study found that past and current restoration practices resulted in two stable states and one transitional state with the probability of membership to the groups controlled by seed mix diversity and planting time. Knowledge of these probabilities will assist managers in developing efficient and self-sustainable restorations and this knowledge can be incorporated into an adaptive management process.

Spurge Flax, a New Grassland Weed for Southwestern South Dakota

Presenter: Milton Haar, Badlands National Park (Milton_Haar@nps.gov)

Other Authors: Teresa Y. Harris and Shelly L. Gerhart, Wall Ranger District Buffalo Gap National Grassland; Michael J. Moechnig, South Dakota State University.

In 2008, a new invasive and exotic plant, spurge flax (Thymelaea passerina), was discovered in the Conata Basin of Pennington County, South Dakota (Kostel, 2009). Initially thought to be new to South Dakota, subsequent investigation found a specimen collected in 1986 in Tripp County, South Dakota, approximately 150 miles away. In 2009, approximately 36 acres were found infested in Badlands National Park. A literature search and personal inquiries revealed that spurge flax is a native of Eurasia and North Africa, where it is a common weed in grain fields and dry soils of south and central Europe and western Asia. In the United States, spurge flax was first discovered in Iowa and northeast Nebraska in 1954 (Pohl, 1955). It has since been found in several states. It remains a relatively rare weed problem, and very little information exits on management, other than it is not grazed by livestock. Resource Managers at Badlands National Park and Buffalo Gap National Grassland would like to respond rapidly and manage spurge flax while the population and infested area are relatively small. They believed that addressing the need for an effective herbicide is the next logical step that needs to be taken. Field trials were established at sites infested with spurge flax within the boundaries of Badlands National Park and Buffalo Gap National Grassland. Treatments consisted of herbicides, application times, and the presence or absence of plant residue. The treatment with the greatest degree of control was Tordon with 2,4-D. The next most effective treatments were Plateau at 8 ounces per acre or Escort at 2 ounces per acre.

References

Kostel, G. (2009) Thymelaea passerina (Thymelaeaceae), in South Dakota. J. *Bot. Res. Inst. Texas* **3(2**), 901-903

Pohl, R.W. (1955) *Thymelaea passerina,* a new weed in the United Sates. Iowa Academy of Sciences, Vol. 62. Dec. 15, 1955.

Bird Communities of Restored Grasslands: DNR-managed vs. Biomass Harvest Sites

Presenter: Neal Mundahl, Winona State University (nmundahl@winona.edu)

Other Authors: Naomi Corey and Bruno Borsari, Winona State University

Resource management agencies and private landowners have idled former agricultural land and planted prairie vegetation or grassland cover on sites in southern Minnesota in recent years for a variety of purposes (Camill et al. 2004, Cunningham 2005, Borsari and Onwueme 2008, Faber 2010). These sites are scattered widely across this region (Cunningham 2005), creating potential habitat for grassland birds in rural landscapes. These grassland habitats generally are small (<10 ha), but often occur clustered together with other small grasslands nearby. Management of these grasslands ranges from idle conditions (old fields), to on-going restorations, to annual harvests for biomass fuel production (Borsari and Onwueme 2008). Research on grassland birds has been very limited on these small, restored grasslands (e.g., Driscoll 2004, Cunningham 2005, Faber 2010).

The objective of this study was to examine bird communities in small (<10 ha), restored grassland habitats in southeastern Minnesota. Specifically, we were interested in comparing bird communities in sets of grasslands that differed greatly in management, one set (13 plots totaling 37.4 hectares) restored by the Minnesota Department of Natural Resources and managed with irregular prescribed burns and the other set (four plots totaling 7.9 hectares) harvested annually for biofuel (dry biomass) production for on-farm use.

Birds at the grassland sites were surveyed by walking multiple transects at each site three to five times each during each of three breeding seasons (May-August, 2008, 2009, 2011). All perched or flushed birds were identified and tallied, and distance to each bird from the observer was measured with a rangefinder for use in density calculations. Bird communities, vegetation structure, and litter depths were compared between biomass fuel production sites and the DNR-managed grasslands.

We recorded 709 birds representing 27 species during surveys: 25 species at the biomass harvest sites and 18 species at the DNR sites. Four generalist or woody-dependent species (Red-winged Blackbird *Agelaius phoeniceus*, American Goldfinch *Carduelis tristis,* Song Sparrow *Melospiza melodia*, Common Yellowthroat *Geothlypis trichas)* represented 58% of all birds tallied at each site (Figure 1). Five species that strongly associate with grassland habitats (Bobolink *Dolichonyx oryzivorous,* Dickcissel *Spiza americana,* Field Sparrow *Spizella pusilla,* Grasshopper Sparrow *Ammodramus savannarum,* Ring-necked Pheasant *Phasianus colchicus)* were found at one or both sites, representing 26% and 29% of birds sighted at biomass harvest sites and DNR sites, respectively (Figure 20).

Bird densities and diversities displayed only slight variation both between biomass harvest sites and DNR-managed sites and among years. Densities (12-18 birds/hectare; Figure 21) were slightly, but not significantly, higher at biomass harvest sites than at the DNR sites each year.

Figure 20. Bird communities (proportional abundances) of biomass plantings (n=476) and DNR-managed lands (n=233), 2008-2011.

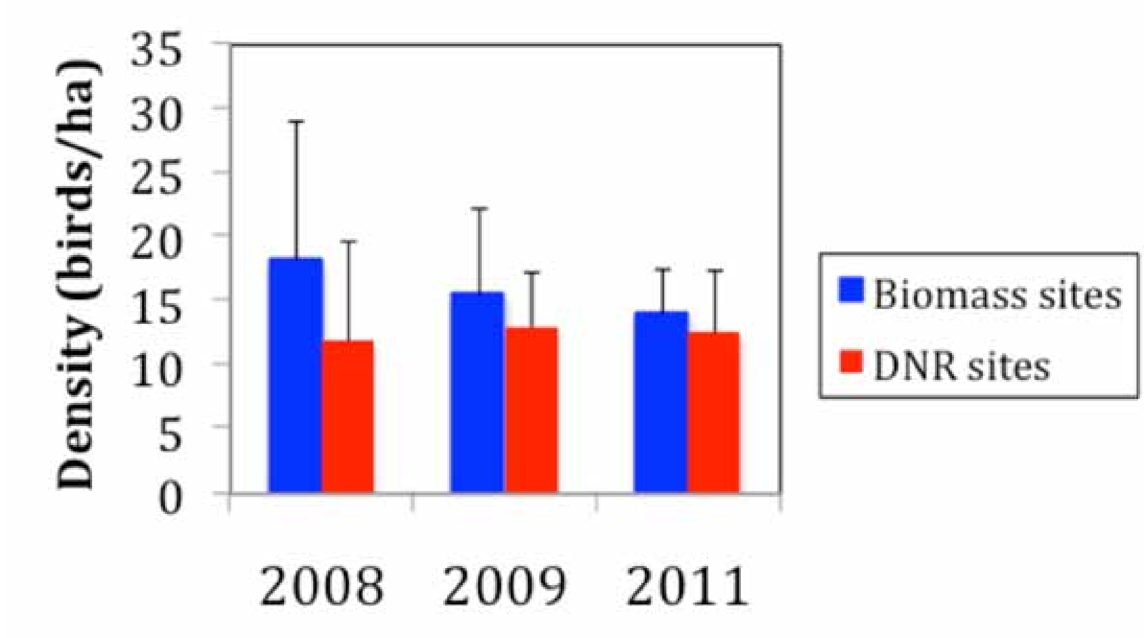


Figure 21. Bird densities (mean ± SD) in biomass plantings and DNR lands, 2008-2011.

Simpson diversities (0.70-0.89) were similar at both types of sites, with only slight changes among years (Table 6).

Although bird communities at DNR-managed and biomass harvest sites exhibited many similarities, they also were very different. Dickcissels, Bobolinks, and Red-winged Blackbirds were much more abundant on biomass harvest sites than on DNR-managed sites, whereas the opposite was the case for Field Sparrows and Common Yellowthroats. These and other variations resulted in significant differences in bird communities between DNR and biomass sites each year, as indicated by Bray-Curtis similarity values much less than 0.6 (Table 6).

Both biomass harvest and DNR-managed sites contained a mixture of forbs and grasses that provided good habitat for birds. Vegetation structure (assessed by a visual obstruction index, a combination of plant height and density) was similar (50-60 cm) at both types of sites. However, average litter depth was five times greater (60 mm vs. 12 mm) at DNR sites than at biomass harvest sites, providing more material and cover for ground-nesting birds.

Table 6. Simpson diversities and Bray-Curtis community similarities of bird communities at biomass and DNR sites, 2008-2011.

	2008	2009	2011	Combined
Biomass sites	0.771	0.896	0.702	0.836
DNR sites	0.803	0.772	0.831	0.868
Bray-Curtis	0.456	0.477	0.315	0.480

Conclusions:

- The majority of birds observed on restored grasslands were generalist species, especially Red-winged Blackbird, American Goldfinch, Song Sparrow and Common Yellowthroat.

- Grassland specialists comprised >25% of birds observed at both biomass production and DNR lands.

- Bird densities and diversities did not differ between biomass harvest sites and DNR sites.

- Dickcissels reproduced successfully at both sites, based on presence of nests, adults feeding young and the presence of fledglings. Bobolinks were successful at biomass harvest sites and Field Sparrows were successful at DNR sites.

- Dickcissels most commonly shared habitats with Red-winged Blackbirds, especially at biomass harvest sites.

- Lack of Bobolink on DNR lands likely resulted from isolated grassland patches and wooded perimeters.

- Field Sparrows seemed to prefer DNR sites with brushy borders and scattered shrubs.

- Lack of litter on biomass harvest sites apparently did not inhibit nesting by grassland species.

- Small, restored grasslands in southeastern Minnesota, whether harvested annually for biomass fuel or left "natural", are able to attract diverse bird communities that include grassland specialist species.

Acknowledgements:

We thank Eric Kreidermacher for graciously allowing us access to his farm to survey birds. The Minnesota Department of Natural Resources provided research permits for bird surveys in the grassland restoration subunits on Kramer Ridge, a part of Whitewater Wildlife Management Area. This research was funded, in part, by a grant to B. Borsari from CERTs (Clean Energy Research Teams) Minnesota.

References:

Borsari, B. & Onwueme, I. (2008) A new lease on life for marginal farmland: convergence of prairie restoration with biofuel production. *Proceedings of the 16th International Federation of Organic Agriculture Movements Organic World Congress. Vol. 2* (eds. D. Neuhoff, N. Halberg, T. Afoldi, W. Lockeretz, A. Thommen, I. A. Rasmussen, J. Hermansen, M. Vaarst, L. Lueck, F. Caporali, H. Hogh Jensen, P. Migliorini, and H. Willer), pp. 608-611. Modena, Italy.

Camill, P., McKone, M.J., Stuges, S.T., Severud, W.J., Ellis, E., Limmer, J., Martin, C.B., Navratil, R.T., Purdie, A.J., Sandel, B.S., Talukder, S., & Trout, A. (2004) Community- and ecosystem-level changes in a species-rich tallgrass prairie restoration. *Ecological Applications*, **14**,1680-1694.

Cunningham, M.A. (2005) A comparison of public lands and farmlands for grassland bird conservation. *The Professional Geographer,* **57**, 51-65.

Driscoll, M. A. (2004) Reproductive success of Savannah Sparrows (Passerculus sandwichensis) and other grassland birds nesting in rotationally- and continuously-grazed cattle pastures in southeast Minnesota. M. S. Thesis, University of Minnesota, St. Paul, Minnesota.

Faber, R.A. (2010) Henslow's Sparrows *(Ammodramus henslowii)* show preference for mullein *(Verbascum thapsus)* stalks as singing perches. *Proceedings of the 21st North American Prairie Conference* (eds. B. Borsari, N. Mundahl, L. Reuter, E. Peters, and P. Cochran), pp. 160-162. Winona State University, Winona, Minnesota.

Carbon Distribution between Plant and Soil Components of Selected Grass Monocultures

Presenter: Larry J. Cihacek, North Dakota State University (Larry.Cihacek@ndsu.edu)

Co-Author: Dismas Macha, North Dakota State University

Carbon (C) sequestration and storage in grassland monocultures has profound implications in the utilization of grasslands for biofuels. We compare the differences between three warm-season native (C4) species and two introduced cool-season (C3) species monocultures grown for > 15 years for seed and forage production on land that was previously in crop production. The grasses were sampled at or shortly after anthesis for aboveground biomass production as well as for root biomass production in the upper 0.6 m of the soil profile. The grass materials were separated into standing vegetation, dead or residue on the soil surface and roots in the surface 60 cm of the soil. Plant materials and soil were analyzed for C and the distribution of the C between plant materials and soil were determined. The proportion of soil C as part of the monoculture system ranged from 95.5 to 97.9 percent of the total organic C with an average of 96.8 percent of the C as soil organic matter. Under the conditions of the grass management system in this study, harvesting plant biomass for biofuel production is unlikely to cause a decline in soil C if the grass is properly managed.

Selenium in South Dakota Grasslands

Presenter: Nancy Anderson, Olson Agricultural Analytical Labs, SDSU (Nancy.Anderson@sdstate.edu)

Selenium toxicity has been a recorded problem in South Dakota Grasslands for over a hundred fifty years. Selenium has been found in high concentrations in South Dakota soils derived from the Pierre Shale and the Niobrara Formations, primarily west of the Missouri River. Producers utilizing these types of soils are forced to manage around the potential for high concentrations of selenium in certain plants to which grazing livestock may be exposed. Knowledge of the geological formations and visual recognition of selenium indicator and accumulator vegetation is essential. Historical knowledge of areas and weather conditions that have previously produced plants high in selenium concentrations is an additional essential tool in the management of these grasslands.

Detecting Channel Riparian Vegetation Response to BMP Implementation in Western South Dakota Ephemeral Streams Using SPOT Imagery

Presenter: Matthew Rigge, South Dakota State University (mbrigge@jacks.sdstate.edu)

Other authors: Kendall Vande Kamp, Alexander Smart, and Nels H. Troelstrup Jr. , South Dakota State University; Bruce Wylie, USGS

Heavily grazed riparian areas are commonly subject to channel incision, a lower water table, and reduced vegetation. Riparian vegetation dissipates flow energy which is critical to maintaining stable channel geometry. Occurrence of prairie cord grass (Spartina pectinata) stands were used as evidence of improved riparian health during post BMP assessment within a watershed frequented by ephemeral gullies. Presence/absence of S. pectinata was recorded during 2010 assessments of ephemeral channels with drainage areas ranging from 6 to 7,584 hectares. Reach locations (n = 115) were delineated using 2010 NAIP imagery resulting in 8-39 sample points per reach subsequently used to extract NDVI values from a series of Satellite Pour l'Observation de la Terre (SPOT) satellite imagery. Normalized NDVI of 1,981 sample points was determined from pre (1987, 1994, and 1997) and post-BMP (2010) imagery. Mean normalized NDVI values calculated for each reach ranged from -1.33 to 3.16. ANOVA revealed no mean difference in normalized NDVI in pre-BMP treatments ($p = 0.85, 0.74, 0.82$) respectively. However, in 2010 (post-BMP) S. Pectinata sites had significantly higher normalized NDVI (1.23) compared to non-S. Pectinata sites (0.89) ($p = 0.01$). Reappearance of S. Pectinata due to changes in grazing regimes along with construction of off-stream watering sources was successfully detected remotely. Establishment of S. Pectinata provides habitat heterogeneity and functions in reducing flow energy which is responsible for the current state of severely incised channels.

Credit: Aviva Glaser, NWF.

"Grasslands provide both ecological and economic benefits to local residents and society in general. The importance of grasslands lies not only in the immense area they cover, but also in the diversity of benefits they produce."

–Conner, R., A. Seidl, L. Van Tassell, and N. Wilkins. 2001. United States Grasslands and Related Resources: An economic and biological trends assessment. http://www.landinfo.tamu.edu

National Wildlife
Federation and
South Dakota
State University