AMERICA'S GRASSLANDS CONFERENCE

WORKING ACROSS BOUNDARIES

PROCEEDINGS OF THE FIFTH BIENNIAL CONFERENCE ON THE CONSERVATION OF AMERICA'S GRASSLANDS

AUGUST 20 – 22, 2019 • BISMARCK, NORTH DAKOTA

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August 20 - 22, 2019
Bismarck, North Dakota

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CONTENTS

INTRODUCTION TO THE PROCEEDINGS

The National Wildlife Federation now has five America's Grasslands Conferences to be proud of with the most recent conference hosted in Bismarck, North Dakota in August 2019. This fifth conference was also the largest by number of attendees and presentations which is a testament to the growing popularity and continued significance of this biennial event. Our co-hosts in Bismarck were the North Dakota Grazing Lands Coalition and North Dakota State University who were instrumental in pulling off a successful conference.

A defining feature of the conference is who attends and the organizations and grassland interests they represent. Of the almost 300 attendees in Bismarck, we had individuals from over twenty seven states, the District of Columbia, plus attendees from Canada and Mexico. Participants included over 30 ranchers and producers, academics from over 20 universities and a number of other research institutions, 35 different non-profit organizations, multiple state and regional wildlife agencies, joint ventures, local and federal agency representatives, and numerous other entities ranging from conservation districts and wildlife reserves to native seed and prairie restoration companies.

This fifth conference was themed "Working across Boundaries" to represent the tri-national nature of grassland conservation in North America with representatives from the Canada, the U.S. and Mexico. The theme also extended to the concept of working across silos from working lands to conservation and restoration focused approaches. The varied presentations on efforts to conserve grasslands and promote rangeland health from different sectors fit the theme well. Not only did we have the most attendees ever, we also had the most presentations (from over a 100 speakers), of any previous conference so there was a lot of content to get through over two days. We started the conference with a full day of five different field trips that saw participants visiting nearby ranches, wildlife management areas, and extension research grasslands to witness soil health and regenerative ranching endeavors.

Over our two full days of presentations and discussions we heard from various groups on the tracking of continued conversion of native grasslands including the latest inventories and analyses. We heard new perspectives on grasslands conservation efforts from our northern and southern neighbors, some of whom had not been to our meeting before. We had over thirty ranchers from the Dakotas and further afield share their ranching stories and examples of successfully balancing ranching and conservation outcomes. Our conference continues to be very highly rated for the many conversations and range of topics covered that are a valuable experience for everyone that attends.

Many thanks to our conference organizing committee and to a number of other local groups in North Dakota that helped us plan the conference. The continued success of this conference owes much to the dedication of a large group of individuals and we hope to continue this valuable partnership in conferences to come. Finally, the generous support from our conference sponsors is what makes America's Grasslands Conference possible and we are grateful for their continued contributions.

Lekha Knuffman
National Wildlife Federation

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- Carolyn Callaghan, Canadian Wildlife Federation
- Arvind Panjabi, Bird Conservancy of the Rockies
- Mark Norton, South Dakota Game, Fish and Parks
- Andrew Jakes, National Wildlife Federation
- Jonas Davis, Ducks Unlimited
- Karl Ebel, Ebel Grasslands Ranch

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- Marshall Johnson, Audubon Dakotas
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- Dana Bohn, North Dakota Grazing Lands Coalition
- Miranda Meehan, North Dakota State University
- Kevin Sedivec, North Dakota State University
- Lekha Knuffman, National Wildlife Federation
- Chad Njos, North Dakota Grazing Lands Coalition

CO-HOSTS

- **National Wildlife Federation**
- **North Dakota Grazing Lands Coalition**
- **North Dakota State University**

KEYNOTE SPEAKER

Dan Flores, Author and Historian

PLENARY SPEAKERS

- Arvind Panjabi, Bird Conservancy of the Rockies
- Elisha Mueller, North Dakota Game and Fish Department
- Jed Rider, Rider Ranch

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Additional thanks: *Delta Waterfowl, Scheels, South Dakota Chapter of the Wildlife Society.*

PLENARY PRESENTATION

A PRAIRIE STATE'S PERSPECTIVE

Elisha Mueller, North Dakota Game and Fish Department

Other Authors: Sandy Johnson, Steve Dyke, Greg Link, North Dakota Game and Fish Department

The word prairie describes what was once the largest vegetative community in North America: the grasslands. However, prairies in North Dakota and throughout the world have been experiencing drastic declines. Prior to settlement in the late 1800s, North Dakota was described as "great uninterrupted expanses of nearly treeless prairie" (Stewart, 1976). However, the landscape described by many early explorers and pioneers has changed considerably, and North Dakota is not the vast expanse of treeless prairie it once was. What used to be a mosaic of grasslands and wetlands is now predominately agricultural land. It is estimated that North Dakota has lost 72% of its original prairie, 60% of its wetlands, and 25% of its woodlands and shrublands.

The rapid loss of native grasslands is of great concern, as this ecosystem supports a wide array of species and constitutes a large part of North Dakota's natural heritage and culture (NDPR, 1999). The loss, degradation, and fragmentation of grasslands has led to the decline of both game and non-game species. Grassland dependent birds, our 'canaries in the coal mine', have shown "steeper, more consistent, and more geographically widespread declines than any other behavioral or ecological guild" (Knopf 1994). Breeding Bird Survey data collected from 1966-2015 show the state's bird, the Western Meadowlark, declines approximately 1.25% each year. This grassland dependent bird, once abundant throughout the state, has lost over half of its population in North Dakota and is now considered rare in the eastern counties. Others, such as the Baird's Sparrow (-3.59), the Chestnut-collared Longspur (-4.24), and the Lark Bunting (-8.03), are also experiencing drastic declines within the state.

To address these declines, state agencies implemented the State Wildlife Action Plan (SWAP) in 2002. The goal of the SWAP is three-fold, to keep common species common, to prevent further listings under the ESA, and

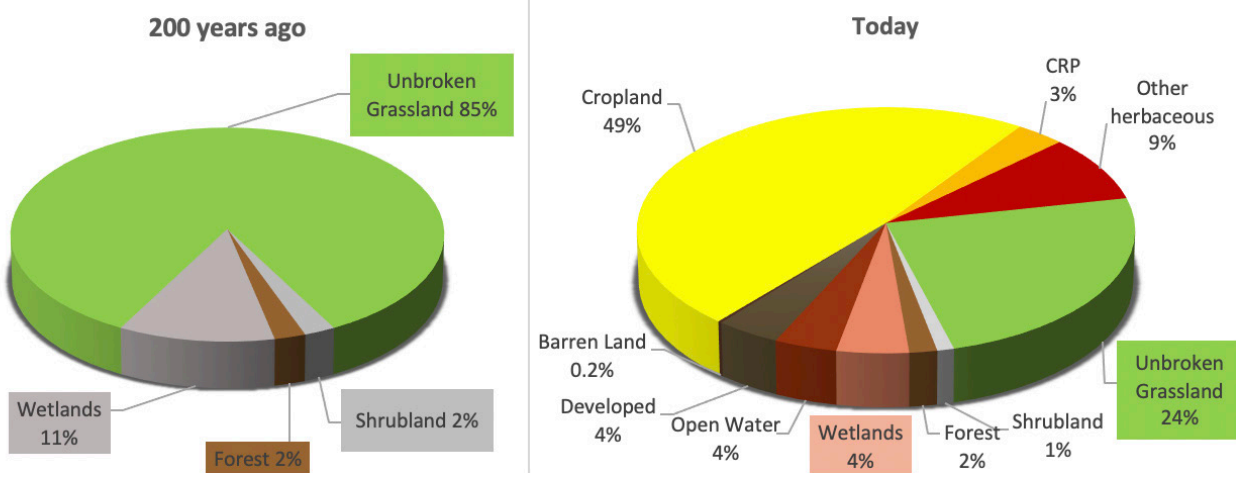

Figure 1. The North Dakota landscape 200 years ago compared to today (NDGF, unpublished).

to preserve the state's fish and wildlife resources for the foreseeable future. North Dakota's latest edition (Dyke et al., 2015) includes 115 species that are considered rare, declining, or at-risk. This includes 47 birds, 2 amphibians, 9 reptiles, 21 mammals, 22 fish, 10 mussels, and 4 insects. The SWAP takes a habitat approach, focusing on ensuring the habitat resources these species need to persist remains on the landscape. Of the 115 species, 48 depend on unbroken grasslands, 54 depend on wetlands, and 13 depend on woodlands.

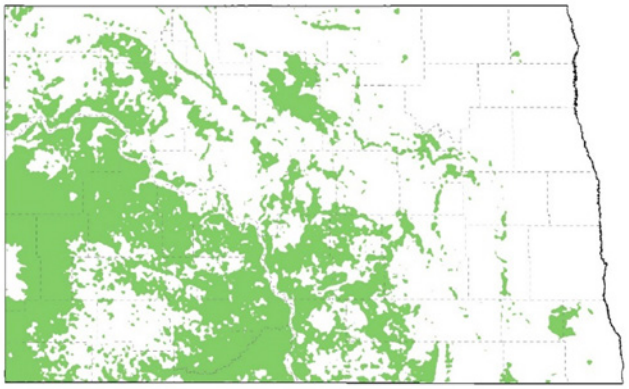

Figure 2. Areas where intact native prairie remains in North Dakota.

These three key habitats face several threats, most of which can be categorized as habitat loss, habitat fragmentation, or habitat degradation. Today, just over 22 million acres have been converted to cropland in North Dakota. Urban sprawl adding approximately 2 million acres to that. North Dakota also hosts a variety of energy development projects which have also contributed to habitat loss and fragmentation. There are currently 33,722 oil and gas wells, mostly localized within the western third of the state. Approximately 15,000 acres of native grasslands have been lost through coal mining and another 55,000 acres are permitted for future mining activities. Further, there are roughly 15 wind farms in North Dakota and many more either in the planning or construction phases. All these pressures together have reduced our native grasslands from about 38 million to just 11 million acres.

As the pressures of a changing landscape continue to impact both game and non-game species in North Dakota and beyond, state wildlife agencies are left with the difficult task of balancing responsible development while managing the state's wildlife resources. To do this, North Dakota Game and Fish Department relies on collaborations with other state and federal wildlife agencies, conservation partners, and private landowners. From supporting research to improving habitat, the Department is focused on taking a proactive approach to wildlife management. If you are interested in learning more about the programs NDGF has been involved with, please visit gf.nd.gov.

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PRESENTATIONS

1. TRACKING THE THREATS, DRIVERS, AND STATUS OF CONVERSION OF GRASSLANDS AND GRASSLAND INVENTORIES

AN ONLINE TOOL FOR MONITORING CUMULATIVE GRASSLAND LOSS ACROSS THE NORTH AMERICAN GREAT PLAINS: THE PLOWPRINT

Patrick E. Lendrum, Science Lead, Northern Great Plains, World Wildlife Fund

Other Authors: Sarah Olimb, Kathryn Ireland, World Wildlife Fund; Eric Ashcroft, Blue Raster LLC

Across the North American Great Plains region, grasslands are being converted to row crop agriculture at an alarming rate. Starting in 2014, World Wildlife Fund (WWF) developed an innovative metric to track the loss of intact grassland across the Great Plains, the Plowprint Report (Gage et al. 2016). The Plowprint has filled a data gap in the ecoregion, documenting the degree and location of grassland conversion that has occurred across the Great Plains dating back to 2009, and targeting areas where future conservation efforts will have the greatest impact. What makes the Plowprint analysis unique is that it tracks *cumulative* grassland loss across the Great Plains region of Canada, the United States, and starting this year, Mexico. Anytime grassland is converted to cropland it enters the Plowprint, and remains as such, even if that same plot is later restored to grass. There is an additional category, perennial, for monitoring areas that were once cropland but no longer are. We track grassland loss this way because of the multitude of ecosystem services that are lost and not easily regained after intact grasslands are first converted, including: soil carbon storage, water infiltration, erosion control, climate mitigation, and critical wildlife habitat to name a few (Bengtsson et al. 2019).

To date, the Plowprint has resulted in an annual report that has been provided to conservation partners as either hard copies or electronically available on the Plowprint website. This year, WWF will start to provide the Plowprint analysis as an online, interactive web-based tool that will expand the utility and outreach of the Plowprint to conservation practitioners and all who are interested (Figure 1). Users will be able to toggle between intact and converted lands, as well as those that have been converted from 2011-present. The user will also have ability to either select predefined areas of interest (CEC Great Plains, Northern Great Plains, joint ventures, states or counties, provinces or municipalities), upload a shapefile, or draw their own boundaries and download a report sheet (Figure 2) with relevant information. Users will also be able to download the data in a tabular format. Information in the report will include the extent of intact habitat and cropland across the region, as well as the composition of those designations (ex. grassland, shrubland, forest, wetland, corn, soy, wheat, etc.), and broad ownership categories (private, state, federal, or tribal). Land classification (intact or plowed) will also be displayed based on the soil quality of the region, and indicator of how suitable the land is for cropland conversion based on soil, topography, and climate variables (Olimb and Robinson 2018).

By building awareness of this valuable conservation tool and monitoring system, WWF hopes to elevate the recognition of grassland loss and the associated reduction in habitat that threatens the ability of the land to provide essential ecosystem services. More information about the Plowprint Report can be found at www.plowprint.org, which is also where the interactive web-based tool will be available once released.

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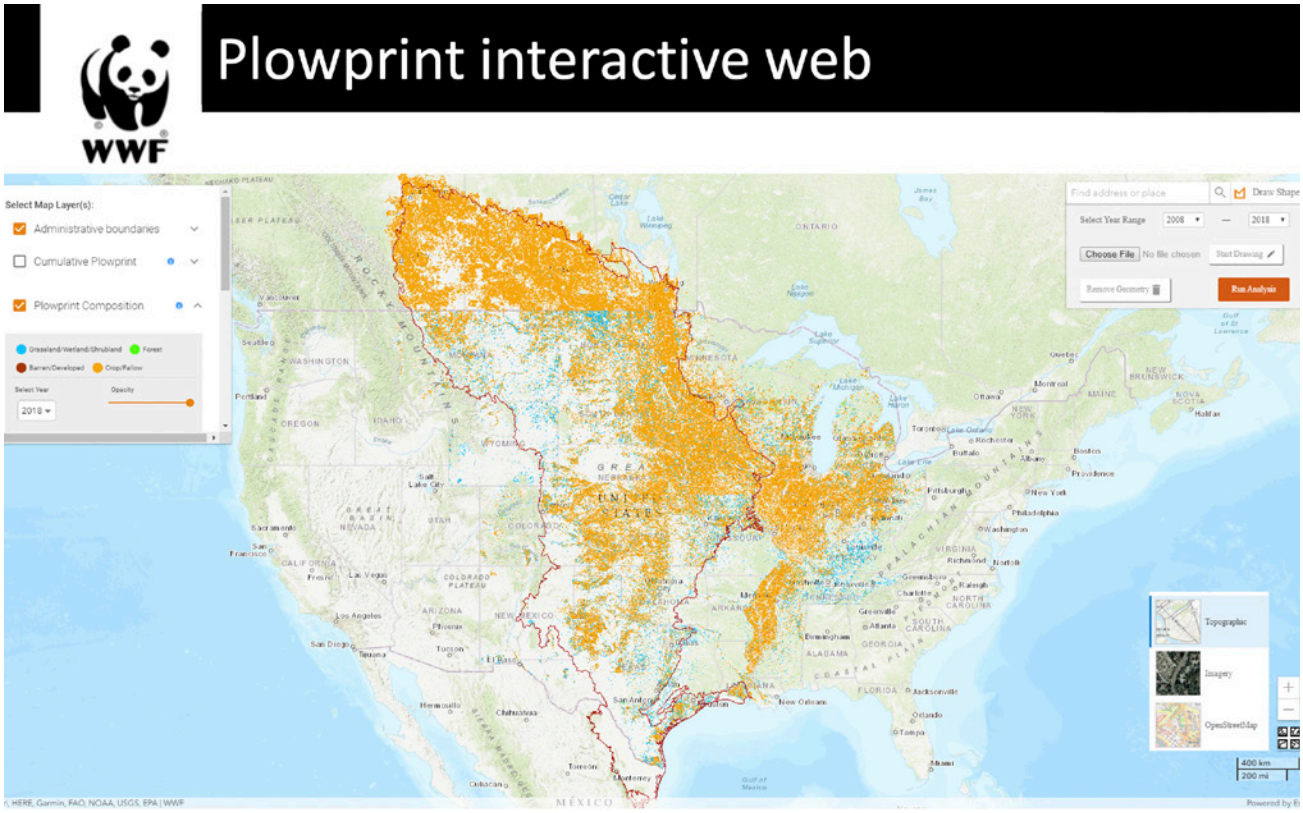

Figure 1. Screen shot of WWF's interactive webmap of the Plowprint Report. The orange indicates the extent of grassland that has been converted across the study region.

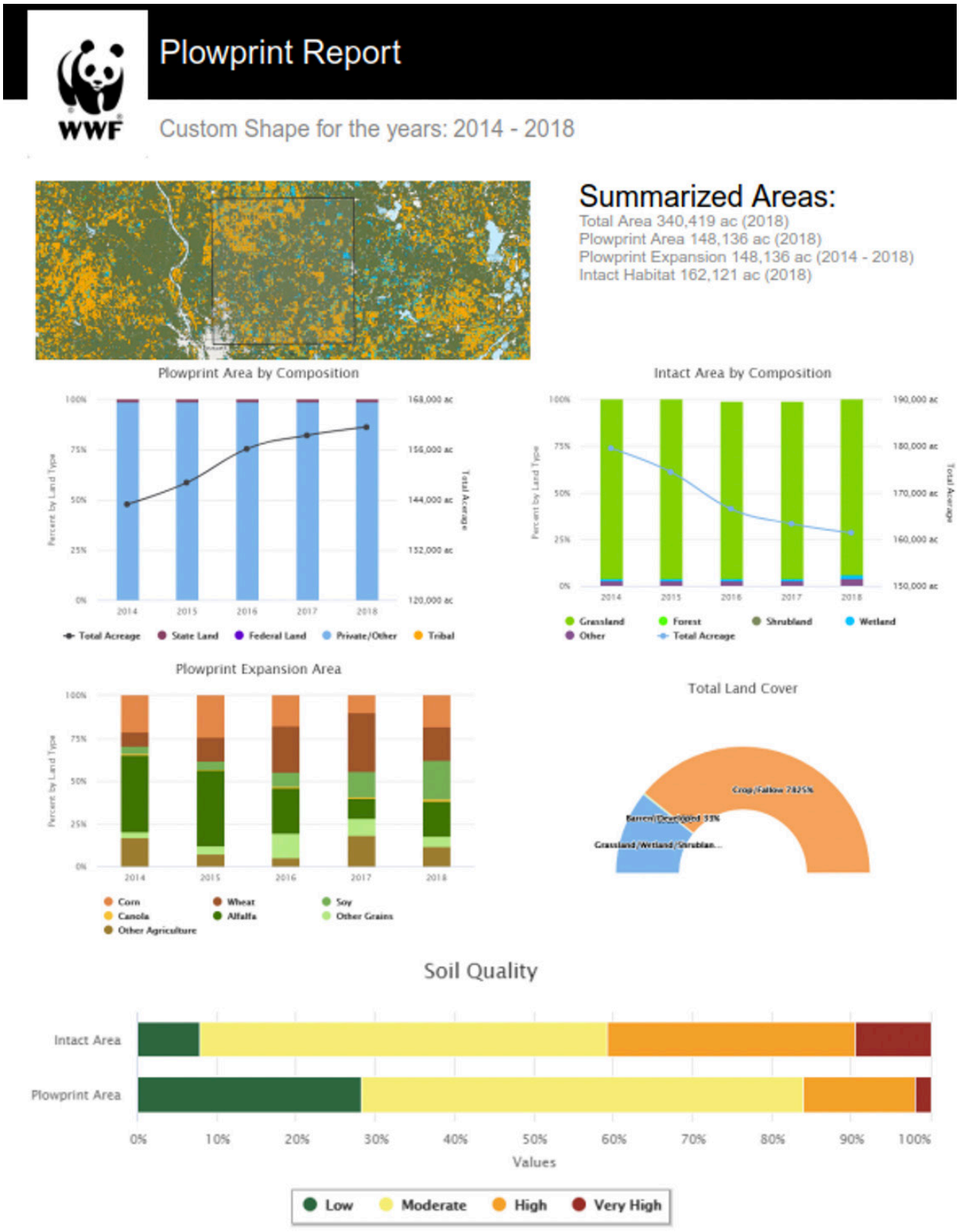

Figure 2. Hypothetical example of output report illustrating summary statistics available for a user defined area of interest across and time.

ENVIRONMENTAL AND HABITAT IMPACTS OF U.S. GRASSLAND CONVERSION

Tyler J. Lark, University of Wisconsin-Madison

Other Authors: Chad Wilsey and Joanna Wu, National Audubon Society

This presentation provided an update on the recent rates of grassland conversion across the conterminous United States and an overview the impacts of conversion on our nation's wildlife, land, and water resources. Previous work found widespread conversion of grasslands to crop production across the U.S. from 2008 to 2012, and our new updates show that grassland conversion has continued at surprisingly high levels. While many of the hotspot locations of elevated land conversion have persisted, areas of new and increasing conversion have also emerged, representing new challenges and opportunities for conservation.

In the 8 years following 2008, over 10 million acres of grassland, shrubland, wetland, and forestland were converted to crop production. During this period, prices for corn and other commodity crops peaked in 2012 but subsequently fell, leading us to expect that land conversion rates may have followed suit. However, despite a 30-40% slowdown of cropland expansion during the most recent years, widespread conversion of habitat to crop production has continued at a rate of nearly 1 million acres per year, representing continued threats to natural and agricultural ecosystems, wildlife, and the environment.

Iowa, Kansas, South Dakota, and Texas experienced the greatest transformation to cropland, with rates of expansion peaking in 2010-11 and falling over time. Minnesota, Missouri, and Nebraska also exhibited similar temporal trends, but at lower magnitudes. High rates of cropland expansion were persistent across the full study period of 2008-2016 in North Dakota and, to a lesser extent, Kentucky. Montana was the only state with greater conversion to cropland after 2012 than before that date, coinciding with vast areas of expiring CRP that presumably returned to crop production.

Geographically, the Prairie Pothole Region in the Eastern Dakotas, the Dissected Till Plains of southern Iowa and Northern Missouri, and the High Plains portion of Kansas, Oklahoma, and Texas remain core regional hotspots of continued cropland expansion relative to previous findings (Lark et al., 2015)

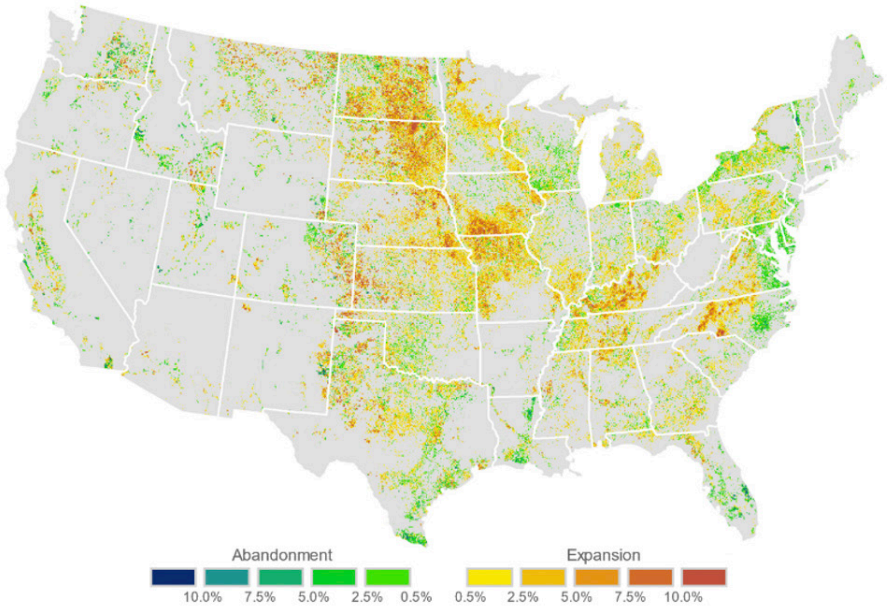

Figure 1: Net cropland conversion 2008-2016.

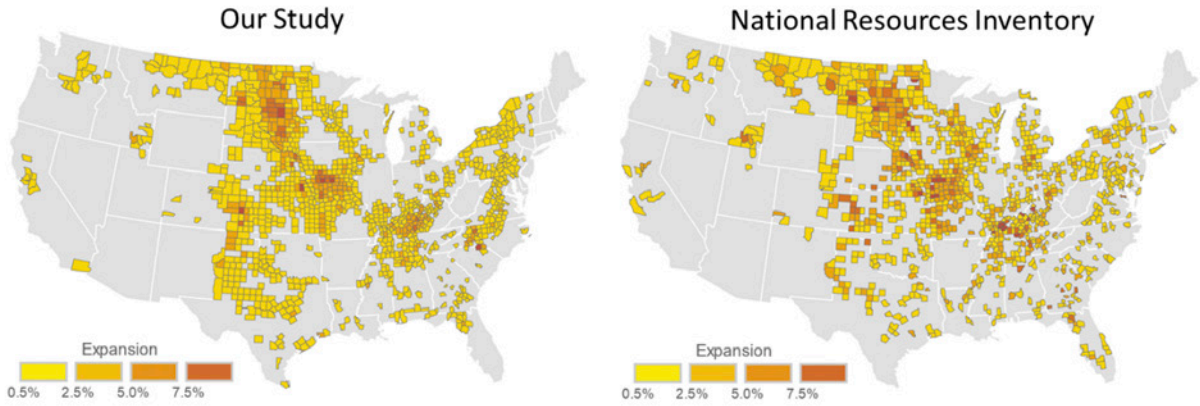

Figure 2: Comparison of results with those from the 2015 USDA National Resources Inventory (USDA, 2015).

However, new locations along the Canadian border in the Northern Great Plains as well as the Interior Low Plateau in Kentucky and Tennessee have also emerged as nuclei of recent expansion. Abandonment, or the conversion of cropland to non-crop uses, was greatest along the eastern seaboard, the Gulf Coast, and parts of the Northwest U.S.

Over 80% of new cropland came from grassland ecosystems. Of those converted, about 2.2 million acres were intact grasslands—those which had not been previously planted or plowed and are most likely to contain native species and sod. Corn, soybeans, and wheat continue to drive conversion, and together, the three crops were planted on over 75% of all land coverted to crop production.

Nationwide, 2.9 million acres of corn and 2.6 million acres of soy were planted directly on land converted to cropland 2008-2016. We estimate that this conversion released more than 14 million metric tons of carbon per year (Spawn et al., 2019) — equivalent to yearly emissions from 13 coal-fired power plants or an additional 11.2 million cars on the road (nearly a 5% increase over current number of U.S. vehicles).

The conversion of natural ecosystems can also have significant impacts on wildlife. For example, from 2008-12, conversion of grasslands and wetlands is estimated to have caused the loss of nearly 2 million milkweed pods per year in the Midwest alone (Pleasants, 2016).

The loss of these critically needed resources may further compromise and challenge ongoing Monarch butterfly recovery efforts.

Our results are consistent with USDA data from the FSA, the NRCS National Resources Inventory, and the NASS Census of Agriculture but provide insights into annual patterns of cropland expansion and abandonment at higher spatial, thematic, and temporal resolution than other available sources.

Methods Overview

We tracked cropland expansion, 2008-2016, using over 25 years of high-resolution satellite imagery from the USDA and USGS to identify the types, amount, and location of all land converted to and from cropland. All reported data and results are from an upcoming publication. We used established recommended practices for estimating land cover change (Lark et al., 2017), and report only land that underwent clear, permanent changes to or from cropland. Land that rotated between cropland and other uses like pasture were put into a separate category of "intermittent cropland" and excluded from the data reported here. Thus, all conversions represent persistent changes to the agricultural landscape. Intact grasslands were identified as those not planted, plowed, or otherwise improved according to the most recent 25 years of data from the USGS National Land Cover Database and the USDA Cropland Data Layer.

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SASKATCHEWAN'S VANISHING GRASSLANDS: POLITICS VERSES GRASSLAND CONSERVATION

Lorne Scott; Nature Saskatchewan

Historically the Northern Great Plains was viewed as one of the most diverse and productive ecosystems in North America. Lush grasslands, millions of wetlands and unique aspen parklands teamed with a variety and abundance of native flora and fauna.

Settlers from eastern Canada, Europe and the United States flocked to western Canada in search of cheap land that they could call their own. Cheap or even free land was the beginning of a number of incentives to convert this rich landscape to agricultural production. The Natural Resources Transfer Agreement in 1930 resulted in the Federal government transferring public lands and resources to the provinces. This removed national oversight on natural resource management.

By 1936 there were some 142,000 farms in Saskatchewan, that number has declined every year since to about 34,000 farms today. It is expected that the number will decline to about 20,000 large corporate farms.

Some poorer quality lands were retained by the province for livestock production. The Federal Government worked with the province in maintaining Community Public Pastures and were leased out to livestock producers. These public lands comprising of some 2.4 million acres were some of the largest, best managed and biodiverse grasslands in the province. Based on short-term political decisions after 70 years of success, both levels of government recently walked away from the Community Pasture Program. Were it not for widespread public outcry, many of the pastures could have been sold to private interests. As it is, patrons have 15 year leases to use the pastures. The biodiversity management component is gone.

The return of World War Two veterans saw a huge demand for land as most veterans came from farming backgrounds. Motorized machinery replaced horses and there was a renewed assault on remaining grasslands, wetlands and aspen parkland landscapes. Depending on political whims, more public lands were offered up for sale to gain public support. The Wildlife Habitat Protection Act was created in the 1980s to protect the most biodiverse public lands from sale or development. Again political pressure from agriculture producers resulted in the Act being gutted to allow for millions of acres of critical public lands to be sold. Saskatchewan conservation organizations envy the cooperative approach to conservation in the United States. In Canada, conservation organizations were

forced to take governments to court to enforce species at risk legislation to protect the Greater Sage Grouse. Conservation organizations in the United States have far greater trust in turning conservation lands over to federal and state governments to manage and preserve. We would never consider this in Saskatchewan.

Wetland drainage has occurred unchecked for decades. There are literally thousands of illegal drainage works causing widespread flooding, huge public expenditures and environmental degradation. Consequently, over half of our original wetlands are gone.

Unfortunately, Canada did not have a Theodore Roosevelt and other great leaders like George Bird Grinnell and J. N. Ding Darling who had the wisdom and conviction to set aside public lands for the public good.

After 150 years of progressive development, Saskatchewan has lost over 86% of our original grassland landscape. We have more species at risk than any other region of Canada. Four of five grassland birds are declining in numbers.

We need more voices in all political arenas speaking up for wildlife conservation. Surveys consistently reveal that conservation, protected areas and wildlife are very important to the public. Unfortunately, the silent majority is not represented at political tables where decisions are made. If our voices are presented at all levels of government, we can make a difference.

The International Union for the Conservation of Nature states that the Temperate Grassland Biome which includes the northern great plains, is the most altered, the most endangered and yet the least protected Biome on the planet.

The future of wildlife is in our hands. As Theodore Roosevelt said many years ago, "OUR WILDLIFE AND ITS HABITAT CAN NOT SPEAK SO WE MUST AND WE WILL."

DEVELOPMENT OF NEW GRASSLAND INVENTORY METHODS AND PROTOCOLS AND SOUTH DAKOTA RESULTS

Pete Bauman, South Dakota State University

South Dakota State University in partnership with The Nature Conservancy, Pheasants Forever, and a host of federal and state partner agencies developed a new methodology to determine the extent of potentially undisturbed land (PUDL) as an indicator of intact native habitats (grasslands, wetlands, and woodlands) in South Dakota from 2014 to the present.

From 2014 to the present, we employed simple GIS methods primarily utilizing the South Dakota Farm Service Agency's Common Land Unit (CLU) data layers from 2013, along with 2012 US Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) county mosaic aerial imagery to evaluate eastern and western South Dakota.

We utilized the CLU data layer, queried to show current and former cropland, to first identify and remove any areas with a cropping history, regardless of current land use. We then employed a step by step analysis to analyze the remaining land in approximately one mi2 sections in order to identify and remove additional historic or current land disturbances. The remaining land tracts were then categorized as potentially 'undisturbed grassland' or 'undisturbed woodland' by simple reason of deduction. Finally, we removed all known water bodies larger than 40 acres as defined by the South Dakota Department of Game, Fish, and Parks' (SDGFP) Statewide Water Bodies layer in order to gain a more accurate interpretation of the remaining undisturbed grassland/wetland/woodland complex.

Overall, 5,488,025 acres (24.2%) of the approximately 22.6 million acres in eastern South Dakota were designated as potentially undisturbed. However, a small portion of the undisturbed acres did have certain

indications suggesting historical disturbance, and 7,161 points were flagged as 'go-back' areas for further analysis. Approximately 14.9 million acres (65.9%) were deemed to have a cropping history according to the FSA CLU data, while approximately 1.6 million acres (6.9%) were found to have some type of land disturbance not indicated by a CLU crop code, for a total of 16.5 million acres (72.8%) of all lands with some type of proven disturbance history. The remainder was occupied by large water bodies. Approximately 1.4 million acres (6.1%) were found to have some sort of permanent protection from conversion. In total, we found only 962,734 acres of the approximately 5.5 million acres of undisturbed land (17.5%) also had permanent conservation protection status, representing only 4.3% of eastern South Dakota's total land base.

We've completed evaluation of approximately 17 million acres (68%) of western South Dakota's approximately 25 million acre land base. Initial analysis suggests that approximately 14.3 million acres of undisturbed grasslands and 225,000 acres of undisturbed woodlands remain within the completed region. Western South Dakota has a complex and dynamic land use history that is not reflected as accurately in the Farm Service Agency's Common Land Unit data. Other records and mapping resources can be inconsistent, and historic rangeland manipulation projects are common forcing a modification of our inventory protocols to capture these previously disturbed, but functionally important grasslands. As a result, 35,535 points were marked for further analysis in western South Dakota to date.

All updated project data is available via South Dakota State University's public data sharing portal 'Open Prairie'. To date, over 500 users have downloaded our data, with 48 new downloads in September, 2019, which corresponded with our recent western SD updates. All of our data links are available via Open Prairie at https://openprairie.sdstate.edu/nrm_data/.

USE OF LIDAR TO REFINE THE SOUTH DAKOTA NATIVE GRASSLANDS INVENTORY

Pete Bauman, South Dakota State University

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We utilized the CLU data layer, queried to show current and former cropland, to first identify and remove any areas with a cropping history, regardless of current land use. We then employed a step by step analysis to analyze the remaining land in approximately one mi2 sections in order to identify and remove additional historic or current land disturbances. The remaining land tracts were then categorized as potentially 'undisturbed grassland' or 'undisturbed woodland' by simple reason of deduction. Finally, we removed all known water bodies larger than 40 acres as defined by the South Dakota Department of Game, Fish, and Parks' (SDGFP) Statewide Water Bodies layer in order to gain a more accurate interpretation of the remaining undisturbed grassland/wetland/woodland complex.

In partnership with data provided by the South Dakota Natural Resources Conservation Service and through modification of basic protocols developed

by researchers in Canada, we have developed an assessment protocol utilizing Light Detection and Ranging (LiDAR) data to assess historic land disturbances not otherwise evident in our original basic methods. Overall, 7,161 points in eastern South Dakota and 35,535 points in western South Dakota (to date) have indications of previous land disturbance and were flagged as 'go-back' areas for LiDAR analysis. As a result, 47% of our suspected disturbance locations in eastern South Dakota were categorized as disturbed, reducing our initial estimate of 5.5 million acres of potentially native habitat to approximately 4.6 million acres (a 17% reduction). LiDAR analysis in western South Dakota has not been initiated at this time.

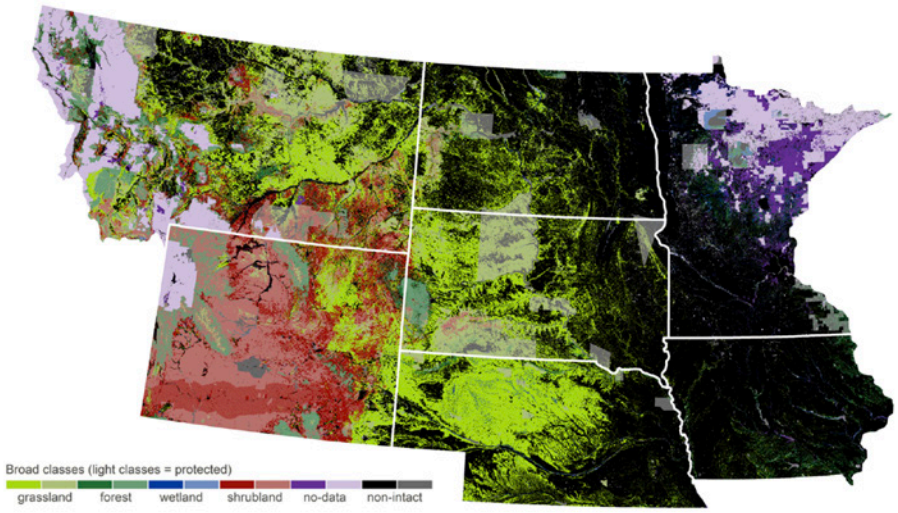

Figure 1: Draft regional map of intact lands in the North Central U.S.

AUTOMATED MAPPING OF INTACT GRASSLANDS AND APPLICATIONS IN THE MIDWEST AND U.S.

Tyler Lark, University of Wisconsin-Madison

Other Authors: Pete Bauman, SDSU; Matt Bougie, UW-Madison

This presentation discussed the methodology and results of mapping intact or undisturbed (native) lands across seven states in the north central and midwestern United States using data derived from crop history records. The mapping methods provide an automated technique to scale a modified approach of Bauman et al. (2016) across greater extents, thereby extending the utility of the data. As a result, the produced maps and data offer some of the first empirical high-resolution, regional-scale estimates of potential native ecosystem locations within the U.S.

Across the region, we found approximately 181 million acres of potentially intact natural lands, including 100 million acres of grassland (55%), as well as shrublands (50 M ac, 28%), forests (25 M ac, 14%), and wetlands (7 M ac , 4%). In total, intact areas constituted 41% of the region, and represented anywhere from less than 5% of the landscape in heavily cultivated counties in Minnesota and Iowa, to over 90% of county area in parts of Wyoming and Montana. Collectively 40% of undisturbed lands were protected or publicly owned, with the remainder held privately and thus more vulnerable to conversion.

Results showed high levels of agreement with a state-level map of confirmed intact (native) lands, suggesting the automated methods developed are appropriate for scaling across larger extents. We also compared the results to a replicable satellite-based estimate of intact lands that could be extended nationwide. Potential applications of these undisturbed land data include improving the mapping and modeling of species habitat, carbon stocks, and conservation priority areas. In turn, these efforts could enable greater public and private protection of remaining undisturbed lands by supporting initiatives such as land and conservation easement acquisitions, supply chain sustainability and zero-conversion commitments, or industry-led moratoria on native ecosystem conversion. All reported data and results should be considered preliminary and are being prepared for an upcoming publication.

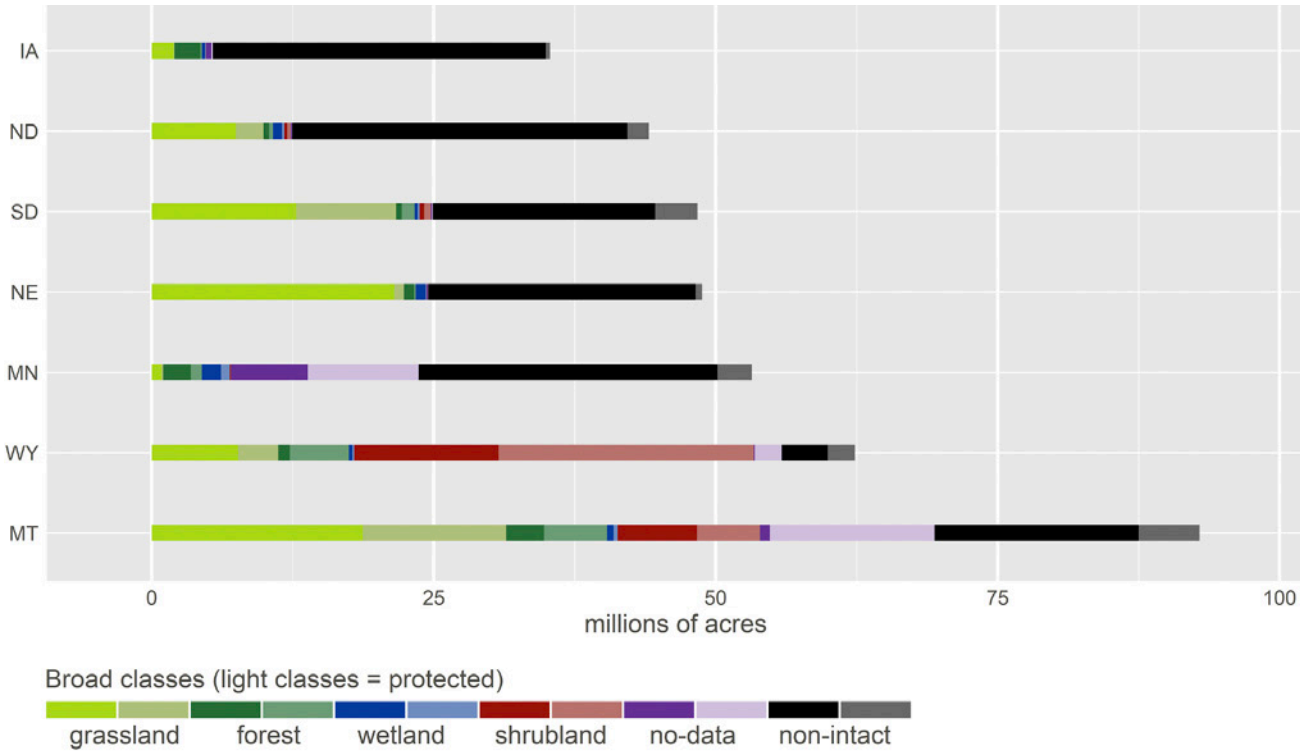

Figure 2: Distribution of intact lands by state, land cover, and protected status.

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ASSESSING GRASSLAND DISTRIBUTION AND CHANGE ACROSS THE NORTH AMERICAN GREAT PLAINS TO INFORM CONSERVATION

Sean Fields, Prairie Pothole Joint Venture

Other Authors: Kevin Barnes, Prairie Pothole Joint Venture

The North American Great Plains has sustained extensive grassland loss and degradation since the 1800s due to agricultural conversion, detrimental management, and infrastructure development. In temperate North America, historic grassland losses total approximately 70%, including complete conversion of the most productive areas (e.g., tallgrass prairie) where nothing but remnant tracts remain (Samson et al. 2004). In the northern Great Plains agricultural conversion is happening five times faster than grasslands can be protected (Doherty et al. 2013). Land use intensification and eroded ecosystem integrity in the Great Plains has resulted in consistent declines in native plants and animals, most notably grassland dependent birds (Sauer et al. 2017). For example, Chestnut-collared Longspur prefers grazed native grasslands from its breeding grounds in U.S. and Canada to its wintering grounds in U.S. and Mexico, and this species has declined 85% since 1966. Given this drastic decline and its full annual life-cycle, conservation efforts will have to operate at the transnational level to stem population declines. Migratory Bird Joint Ventures are well suited partnerships to spearhead this effort.

Migratory Bird Joint Ventures (JV) are collaborative, regional public-private partnerships that conserve habitat for the benefit of priority bird species. Joint ventures bring diverse partners together under the guidance of national and international bird conservation plans to design and implement landscape-scale conservation efforts. The partnerships have begun to focus resources on filling information gaps to understand the mechanisms inhibiting grassland bird population growth. Understanding how the rate of grassland loss compares to conservation gains informs conservation time frames and what policies and resources are necessary to stem population declines (Doherty et al., 2013). Although JVs have a long history of success in leveraging public and private resources to focus on regional conservation needs, cooperation between JVs at larger scales is only beginning to coalesce as JV networks realize the necessity of larger scale planning and action for conservation of migratory birds across full life-cycle geographies.

In partnership with ConocoPhillips and the USDA Farm Services Agency, seven JVs are working towards a common goal of strategically conserving grasslands of the Great Plains and northern Mexico (Figure 1). The partnership has embarked on a multi-phased project to: 1) map the remaining undisturbed native grasslands across three countries 2) estimate rates of grassland conservation versus loss rates to inform spatially-explicit grassland protection and restoration objectives, and 3) expand our network with new and non-traditional partners to build awareness and ultimately achieve shared conservation goals to benefit the migratory birds and rural communities across the landscape.

Methods

We adapted methods from previous work that identified undisturbed grasslands in portions of the Great Plains, particularly the deductive approach to identify grasslands using remotely sensed land cover data employed by Gage et al. (2016), and the work of Bauman et al. (2016) and Olimb et al. (2017) to further define undisturbed native grasslands. In the United States portion of the study area we used the Common Land Unit (CLU) dataset to identify potentially undisturbed lands: this is a spatial time-series dataset administered by the US Department of Agriculture (USDA) Farm Services Agency (FSA). The FSA annually updates the CLU dataset by spatially delineating land units and updating land use as it pertains to agricultural cultivation, and residential and industrial disturbances. For Canada and Mexico where CLU data are not available, we used time series landcover data to identify cropland; Cropland Inventory datasets from Agriculture and Agri-Foods Canada were used for the Canada mapping and the National Institute for Statistics and Geography (INEGI) landcover data for Mexico. We removed all areas previously mapped as cropland and any other developed areas along with trees, large wetlands and barren land. All the remaining areas were identified as potentially undisturbed grasslands.

For those areas identified as undisturbed lands in the deductive process, we used a supervised classification remote sensing approach with Sentinel 2 satellite time series data to further refine the results from the deductive mapping process. We partitioned the study area into major ecological regions to facilitate the remote sensing process and accuracy assessment results indicate overall map accuracy to be >80% for all regions.

To identify rates of grassland conversion and protection, we used USDA Cropland Data Layer annual mapping products along with the Protected Areas Database of the United States (PADUS) administered by the U.S. Geological Survey. We used similar datasets available in Canada and Mexico that identify loss and protection rates. Two loss rates were estimated to provide multiple scenarios to inform conservation planning.

Results & Discussion

Our results indicate that the amount of potentially undisturbed grasslands vary greatly across the study area (Figure 2). The Playa Lakes JV of the central Great Plains and Northern Great Plains JV to the north contain the greatest amount of potentially undisturbed grasslands, while the Prairie Habitat JV in Canada

and the Prairie Pothole JV in the US experiencing the greatest grassland loss rates (Figure 3). When comparing the grassland protection rates to the grassland loss rates, it becomes clear that additional effort should be focused on the Canadian prairies to counter the high conversion rates. Additionally, shrub encroachment in the southern Great Plains and Chihuahuan Desert grasslands continues to threaten grassland birds. The final results of the landcover classification phase will identify geographic areas of concern that are experiencing shrub encroachment. All JV partnerships must make efforts to bolster grassland conservation efforts to counter the high conversion rates as we strive to stem grassland bird population declines. Our final results will provide an information platform for the JV network to use our common voice to raise awareness to increase conservation funding and delivery to achieve our conservation goals for grassland protection and restoration.

Figure 1. The Migratory Bird Joint Ventures of the Central Grasslands JV Network. PHJV – Prairie Habitat JV, PPJV – Prairie Pothole JV, NGPJV – Northern Great Plains JV, RWBJV – Rainwater Basin JV, PLJV – Playa Lakes JV, OPJV – Oaks and Prairies JV, RGJV – Rio Grande JV.

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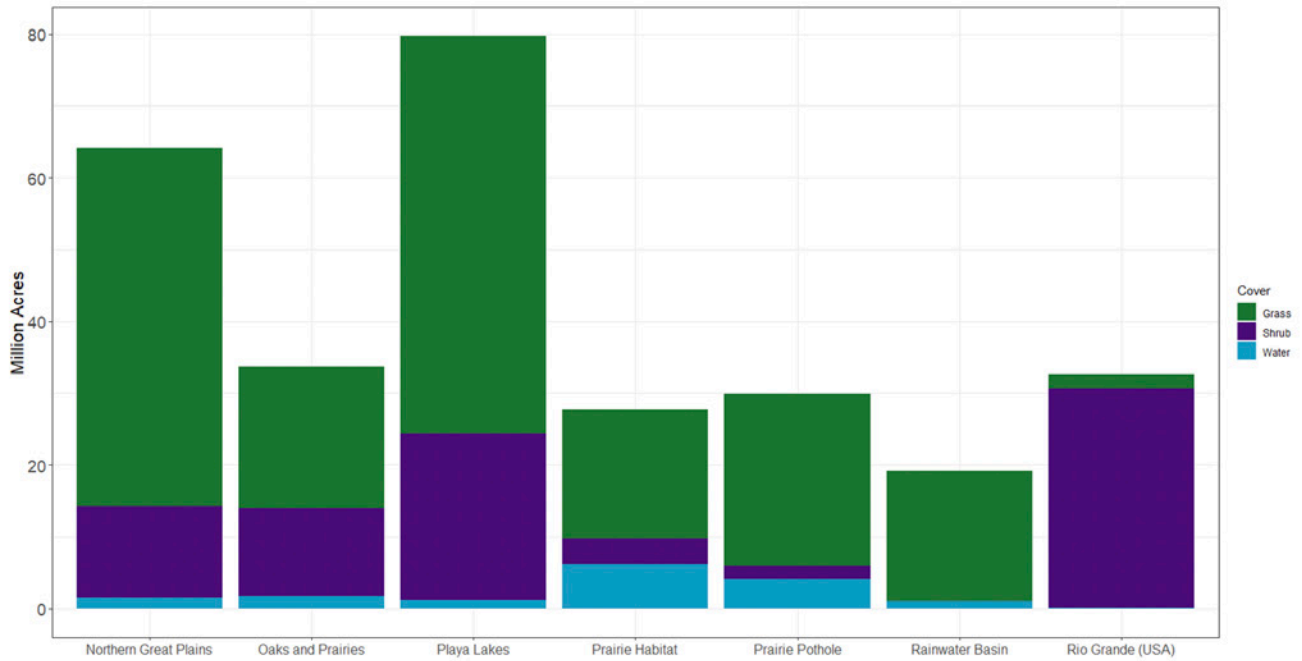

Figure 2. Potentially Undisturbed Lands after the deductive phase of the mapping process. The Existing landcover datasets were used to provide the proportion of grass, shrub and open water in each Joint Venture. Remote sensing analysis will provide the final results when completed.

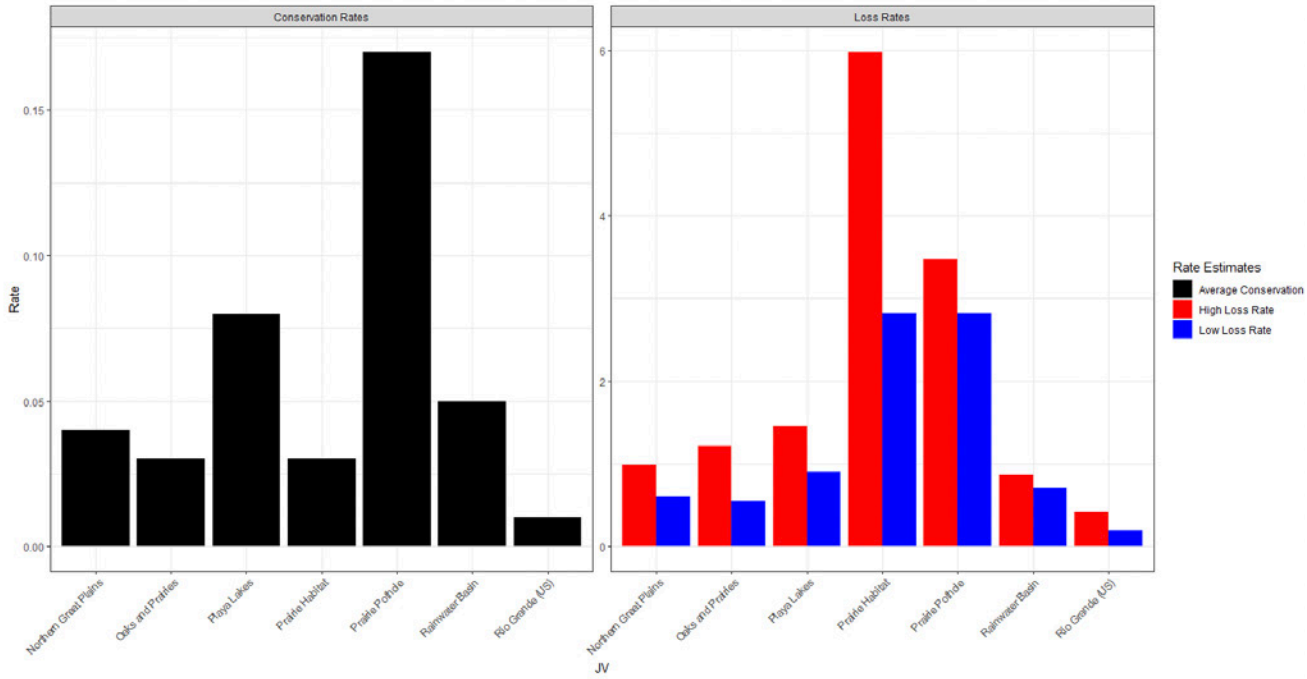

Figure 3. Grassland protection rates (left graph) and multiple loss rates (right graph) for each of the 7 Migratory Bird Joint Ventures in the study area.

2. GRAZING AND MANAGEMENT

USING ADAPTIVE MANAGEMENT TO IMPROVE TALLGRASS PRAIRIE

Marissa Ahlering, The Nature Conservancy

Other Authors: Daren Carlson, Minnesota Department of Natural Resources, Sara Vacek and Melinda G. Knutson U. S. Fish and Wildlife Service, Sarah Jacobi and Vicky Hunt, Chicago Botanic Garden, Jessica C. Stanton, U. S. Geological Survey, Eric Lonsdorf, Institute on the Environment

Grasslands in the northern tallgrass prairie have experienced dramatic loss of habitat (Comer et al. 2018). What remains has been degraded by invasive species (DeKeyser *et al.* 2013), and the increase in invasive cool-season grasses has been a growing concern for land managers across the region. Adaptive management (AM) is frequently recommended as an approach to address management problems (Knutson et al. 2010), but successful implementation of AM is uncommon.

We used AM to provide management alternatives for the native tallgrass prairie plant communities in western Minnesota and eastern North and South Dakota, USA. The objectives of the AM project were to increase the cover of native vegetation, decrease the cover of invasive vegetation, increase native species diversity and increase structural diversity. The management alternatives we evaluated included prescribed fire, conservation grazing and rest. The AM model evaluated both the type of management action and the frequency of management actions that are most likely to improve the condition of the prairie. We employed Bayesian updating to generate annual results using a state-based model, and we used a logistic regression approach to complement the AM model.

After nine years of data collection, data on 130 management units were included in the analysis. Overall, the cover of native vegetation increased for low-quality sites, but the cover of woody vegetation increased at high-quality sites. Under both the AM and logistic regression model, burning enhanced the native plant community. The logistic regression results also suggested that grazing was less likely to improve the condition of the prairie, especially for low-quality sites. However, the starting condition or state of the site was the best predictor for achieving management goals over the nine years.

The AM model generates state-based results for each of the sites included in the model, providing managers with added information when making management decisions, but one of the challenges with this AM model is that season of burn and type of grazing practice were not included in the model. Furthermore, the distribution of sites across the different starting states was uneven for certain types of management. For example, few of the high-quality sites experienced grazing over the nine-year period. Therefore, drawing conclusions about the impacts of grazing on cool season grasses or native vegetation may not yet be appropriate. Closing the AM loop can be challenging, especially when working across agencies, but with consistency in leadership and dedication of partners, we demonstrate that a multi-agency AM approach can be achieved.

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COVER CROPS & LIVESTOCK INTEGRATION ON CROPLAND AS A TOOL TO MAINTAIN AND MANAGE GRASSLANDS – PERSPECTIVES FROM A DUCK BIOLOGIST AND A RANCHER

Donn Nelson, Cattle Grazer & Farmer and Tanner Gue, Ducks Unlimited

The grasslands and wetlands of the Prairie Pothole Region (PPR) are some of the most unique habitats in the world. They support hundreds of different wildlife species including more than 50% of North America's breeding duck population. However, pressures to convert grasslands and wetlands to row-crop agriculture also make the PPR one of the most threatened ecosystems in the world. In this presentation, we briefly discuss 1) some current trends in conservation and agricultural practices in the PPR, 2) a new working lands conservation program intended to reduce habitat conversion pressures, and 3) firsthand perspective on the benefits of this novel approach to agricultural producers and our natural resources.

Current conservation program strategies on privately owned and operated lands in the PPR have proven effective. For example, Ducks Unlimited and the U.S. Fish and Wildlife Service have perpetually protected 1.6M acres of grassland and more than 1.5M acres of wetlands in the PPR of the Dakotas and Montana alone. United States Department of Agriculture programs, like the Conservation Reserve Program and the Environmental Quality Incentive Program, are also significant short-term conservation options for agricultural producers. Even with extensive conservation program options like these, grassland loss rates continue to exceed habitat protection rates in the PPR (Doherty et al. 2013). Between 2006 and 2011, more than 1.3M acres of grasslands were converted to row-crop agriculture, primarily for corn and soybean production (Wright and Wimberly, 2013). During this same time when crop rotations have become less diverse in the region, the number of cattle have also declined.

The loss of grassland and wetland habitat taken together with reduced agricultural diversity has resulted in several negative impacts. At the scale of individual farms and ranches, the primary impact is degraded soil health. Soils in poor health have low organic content, reduced nutrient availability to cash crops, increased soil compaction, and reduced water infiltration. This may ultimately lead to reduced profitability of cropland and grassland acres for farmers and ranchers. Reduced soil health at the local farm and ranch scale can also have implications at a much larger watershed scale. For example, unhealthy soils may be susceptible to to increased rates of surface runoff, which is frequently associated with increased sediment loads deposited into downstream aquatic environments. Increased runoff also carries fertilizers such as nitrogen and phosphorus, resulting in eutrophication of downstream environments. The conservation community must work closely with farmers and ranchers to identify functional solutions that promote sustainability for both the agricultural community and habitat conservation.

To address degraded soil health and associated resource concerns, some innovative producers in the eastern Dakotas have started using cover crops and integrating livestock on their cropland. Diversification of cropland systems using cover crops, a type of plant or mixture of plants grown in conjunction with or between principle cash crops, can improve overall soil health and functionality by restoring organic matter, reducing wind and water erosion, increasing soil aggregate development and porosity, reducing soil compaction, and increasing water infiltration (Hoorman 2009). Importantly, integration of livestock on cropland further enhances soil health. Grazing stimulates plant root growth, urine and manure distributes carbon back to the soil, and the nutrient cycle process is strengthened (Hillmire 2011).

The use of cover crops and livestock integration may also have benefits for conservation of grassland habitat. For example, increased grazing days on cropland may increase the rest recovery period on adjacent grasslands, providing enhanced nesting cover for ground nesting birds and thermal cover for overwintering wildlife species. Perhaps most importantly, these kinds of practices may reduce pressures to convert grassland and wetland habitat by providing a mechanism to keep livestock on a landscape that currently lacks agricultural diversity.

With assistance from local landowners, the North Dakota Natural Resources Trust, Pulse USA, Millborn Seeds, and North Dakota's Outdoor Heritage Fund, Ducks Unlimited built a conservation program called the "Cover Crop & Livestock Integration Project" (CCLIP). The primary goal of CCLIP is to offer short-term voluntary project options that provide landowners with the incentive needed to kick-start cover crops and livestock integration on cropland. Farmers and ranchers interested in this 5-year program have the opportunity to plant cover crops and develop grazing infrastructure on cropland (Fig. 1). CCLIP provides up to 60% cost share on grazing infrastructure that consist of, but are not limited to fencing materials, windbreak panels, rural water hookups, well hole and casing, water tanks, solar and/or wind stations, electrical hookups, water pumps, and pipelines. CCLIP also provides up to 60% cost share for expenditures associated with cover crop seeding equal to as many as but no more than two years for each enrolled cropland

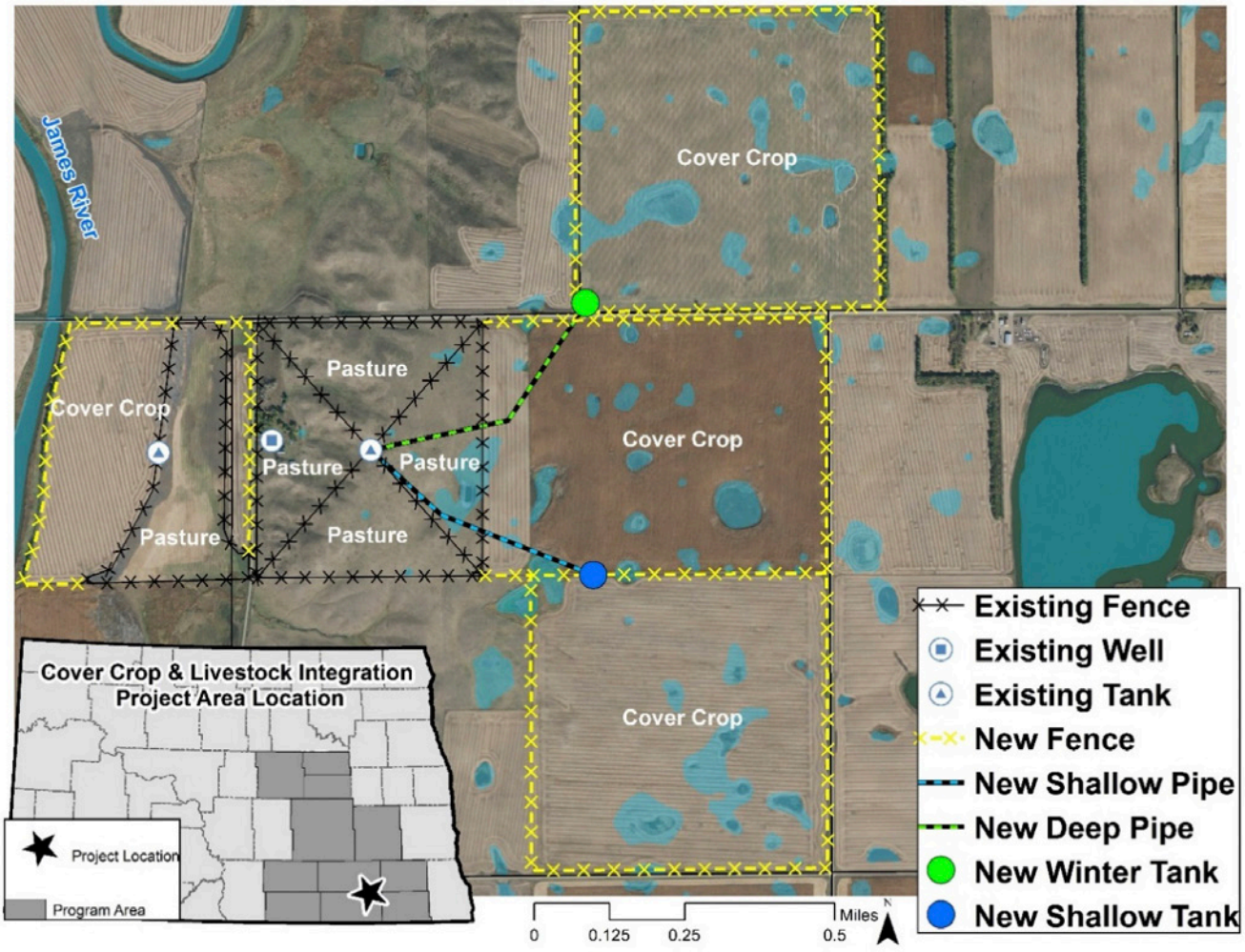

Figure 1. Example of a Cover Crop & Livestock Integration Project on an operation in Dickey County, North Dakota.

acre. North Dakota producers enrolling in CCLIP may also receive a discount on cover crop seed mixes from Pulse USA, should producers choose to order seed from Pulse USA. Provisions include no-till practices, cover crops planted at least two out of five years, no wetland drainage for the extent of the agreement, and grazing management plans. CCLIP partners will help producers develop grazing plans based on duration, rest recovery time, available crop residue, and cover crops. However, grazing plans will give farmers and ranchers the flexibility to adapt given changing resource conditions while maintaining their soil health goals.

The primary objective of CCLIP is to assume some of the upfront costs and risks of implementing new sustainable practices like cover crops and livestock integration on cropland. These practices are economically and biologically impactful to the farmer and rancher, as well as our natural resources. As alternative and flexible working lands conservation programs like CCLIP expand and practices are adopted at larger spatial scales, anticipated gains in soil and water health through diversification of agricultural operations will benefit rural communities, watersheds, and North America's grasslands.

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SIMULATED WATERSHED-SCALE IMPACTS OF GRAZING MANAGEMENT PRACTICES ON STREAMFLOW CHARACTERISTICS AND DOWNSTREAM FLOODING

Srinivasulu Ale, Associate Professor, Texas A&M AgriLife Researchqsoi

Other Authors: JungJin Kim, Texas A&M AgriLife Research

Grazing management practices can have a significant influence on streamflow characteristics and downstream flood-risk. The impacts of heavy continuous (HC) and light continuous (LC) grazing, and adaptive multi-paddock (AMP) grazing practices on streamflow characteristics and water balances in the Lower Prairie Dog Town Fork Red (LPDTFR) watershed in the Southern Great Plains and the Apple watershed in the Northern Great Plains were compared using the Soil and Water Assessment Tool (SWAT). The results indicated that the adoption of AMP grazing on rangelands in the LPDTFR watershed reduced stream flashiness by about 36% when compared to the baseline HC grazing. A similar analysis is currently being carried out for the Apple watershed and the influences of climate and soil properties on the grazing management impacts in these two watersheds will be compared.

MEDICINAL GRAZING AND UNEXPECTED OUTCOMES: HOW WE DECOMMISSIONED OUR DEWORMING PROGRAM AND ENHANCED OUR LIVES

Kirsten Holland Robertson, Pecan Dale Farmstead

We own a craft small-ruminant farm in Pelzer, SC. As we watched barber's pole worms become resistant to chemical dewormers, we decided to investigate mimicking nature through management as a deworming program.

Deadly Worming Issues

A 2010 study showed that benzimidazoles ("white" drenches, e.g. Safeguard® or Valbazen®) were ineffective on 97% of farms tested due to resistance to the dewormer. We had animals that had died from worms. We knew there had to be a better way.

We Decided to Mimic Nature

It seemed that small ruminants in the wild did well without chemical dewormers, so we decided to change our management to mimic nature. This was the plan:

- Graze high with lots of rest for the pastures. Worm larvae stay below 4", so graze 6" minimum.
- Allow browse for goats who naturally like it. Again, that's to avoid worm larvae near the ground.
- Allow self –medication through plant choice.
- Eradicate all congregating areas. These tend to concentrate worm loads.

I decided if I was going to do it AT all, I was going to do it ALL!

How?

- Hedgerows (Forage Fences)
- Medicinal Paddocks
- Management Intensive Grazing
- No congregating areas, including shelter, shade and water except in emergencies

Hedgerows (Forage Fences) - Chose coppiced black locust because of Dr. Luginbuhl's research at NC State. Black locust was the most palatable and had the fastest regrowth of the goat forage trees he studied. It is a natural dewormer. Because it is a tree, the goats are drawn to it. It is also a nitrogen fixer. The biggest issue is that the management plan includes cutting the trees back to knee height (coppicing) every year. This is miserable because of their thorns. Also, I understand that black locust is poisonous to horses.

Forage Fence setup: 2 Cattle panels 6 feet apart with a 2 foot Forage Browse zone on inside boundary. 2foot grow zone in the very center to ensure that the animals don't eat the trunks of trees.

Medicinal Paddocks - Chicory, per John Andrae of Clemson University, has worm inhibiting properties in lambs. It is best if planted in paddocks as opposed to sprinkled throughout pasture. Our management plan runs the goats and sheep through one chicory paddock every week.

Management Intensive Grazing - Move them every day, giving the land as much rest as possible. In times of drought, this can give the dry weather time to kill and desiccate the worm larvae. We started grazing the road right-of-way, orchard space and yard to give pastures at least 35 days of rest.

No Congregating Areas (barn, shade, water) - In congregating areas grass gets eaten down more so worms are available in that bottom 4". Watering areas can stay wet which is the best habitat for worms. Small ruminants poop when they stand, so more manure accumulates wherever they congregate. The animals get new water and shade areas in every paddock now. RESULTS! – We went almost immediately from deworming 2-3 times/year to zero times in 4 years!

Unexpected Outcomes

Beauty and Bouquets - Did I mention that I planted native wildflowers in between the trees in the forage fences? Did I mention that the native seedbank sprang to life with wildflowers? We now have free bouquets whenever needed during the spring, summer and fall. We envision a 'you pick' enterprise as part of our retirement plan, but even if not, it's just plain soul-feeding.

Native Pollinators - Monarchs found the first 6 plants ever planted on our property! How do they do that? Zebra swallowtail caterpillars, which only eats passionfruit vine, appeared out of nowhere. Native plants really matter!

Honey - I had grown up beekeeping with my father so had a sentimental attachment to it. I had tried beekeeping on my farm, but it was too labor intensive. A neighboring beekeeper found out about what I had going on with all of the native flowers and grasses and asked if he could put 20 hives on my property. Free honey, no mess, no smell, no cost!

Spiders - The spiders in my pastures are crazy! "The researchers found that when spiders were present, overall plant diversity increased. This is not because the spiders ate more grasshoppers. Instead, it's because the grasshoppers shifted to a diet of goldenrod, which knocked the goldenrod back just enough to allow other plants to establish. It's not just plant diversity that changed either. Spiders also caused an increase in both solar radiation and nitrogen reaching the soils!" count the spider webs in a square meter of pasture. I like to find 40. To support such a population of spiders there must be a large population of arthropods which are the spiders main diet. As arthropods are responsible for 80% of nutrient cycling this tells me what's likely to be going on.

Endangered Species Habitat - In my quest to add native flowers to the farm, I became close allies with the SC Native Plant Society. They gave me some endangered species (because they can't sell them), and they are proliferating nicely in the forage fences. This makes me so happy!

More Forage - Having the hedgerows that grow up over 6' tall actually gave 0.2 acres of extra vertical forage. This even includes taking the 'lost' area out of the center of the forage fences. Because of the Management Intensive Grazing, the pastures were WAY more prolific so I lowered hay use and increased stocking rate.

More Birds - With the insects came more birds of several species. Their droppings add more phosphorus to the pastures, and the birds themselves add fly control, beauty and song.

Dung Beetles - A couple of years after we stopped using chemical dewormers, we found that our dung beetles thrived. For those with cattle, dung beetles have been proven to deter flies. They can decompose a cow pie within a few days, which makes it impossible for fly eggs to hatch. For all grazing species, some dung beetles tunnel and actually roll balls of manure into the ground thereby injecting fertilizer into the root zone without the farmer lifting a finger! Dewormers disrupt the dung beetle life cycle and kill the larvae.

Shade and Fungi Repository - I didn't realize that the black locust trees would grow back up to 15feet every year. This made convenient shade and the fungal nature of having trees gives a fungi home, adding a new, linear ecosystem to the pastures.

Fruits and Nuts - Remember that the black locusts are nitrogen fixers? I planted about 30 different types of fruit and nut, mostly native, beside those nitrogen fixers. Blueberries, American and Asian persimmons, serviceberries, highbush cranberries, hickories, pecans, black walnuts, hazelnuts, mulberries, melonberries, chokeberries, cornelian cherries (cornus mas), cornus kousa, jujubes, heritage apples, Asian pears, European pears, crabapples, pineapple guavas, pomegranates, grapes, passionfruit and figs are all planted in a linear wild profusion. We have our own Garden of Eden, which is what my husband always wished for. We decommissioned our deworming program, and ended up living in a thriving Garden of Eden!

Best Unexpected Consequence - Last unexpected consequence is that 5 years ago I was ready to sell the farm because I was tired and simply worn down. This journey has made me fall in love with my farm again. That, my friend, is Regenerative Grazing.

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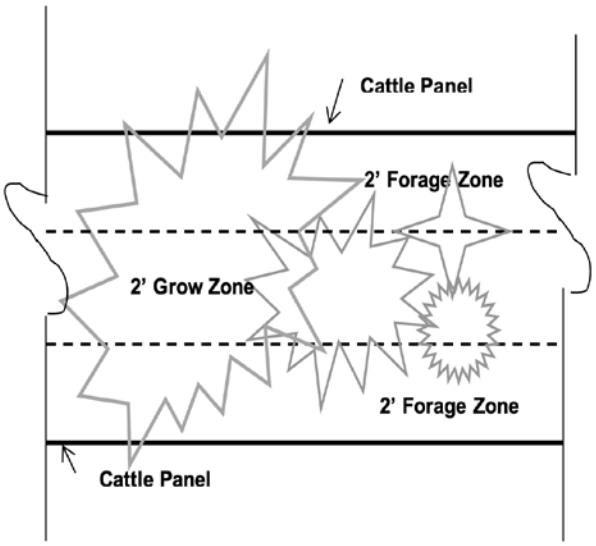

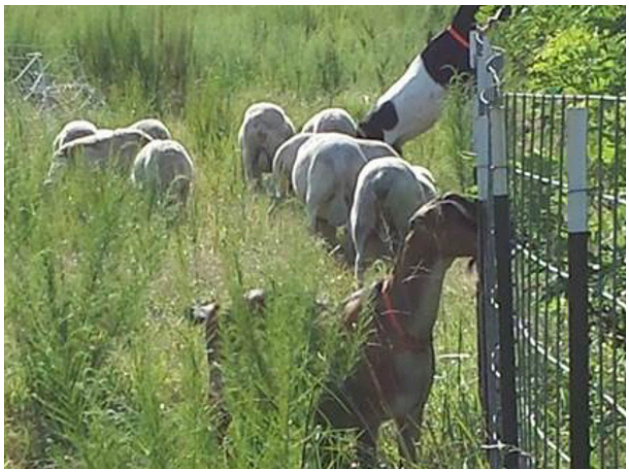

GRASSLANDS – BRINGING FAMILY TOGETHER

Crystal Neuharth & Johnathon Neuharth, Prairie Paradise Farms

Grasslands have always brought our family closer together. My son, Johnathon (11 yrs.) and I shared our journey at Prairie Paradise Farms located west of the Missouri River in Stanley County, South Dakota. There my husband, Levi, and I raise our 3 children, Johnathon, Justin, and Kaydee. We do the majority of our management with all 3 kids as we feel experience is the best teacher. Our goal is for our kids to fall in love with what we do at a young age. "Educating the mind without educating the heart is not education at all." –Aristotle. First impressions last and we want to create the best one we can. Same goes for all children. Family farms are becoming fewer and fewer and it's hard for kids to experience this way of life. We started an annual Family Farm Visit Day the first Saturday in May on our farm this last year. Families can come and learn about farm life and soil health. "Teaching children about the natural world should be seen as one of the most important events in their lives". –Thomas Berry. If we don't make it a priority to provide this experience and knowledge the children won't feel it is as big of a priority as it really is. Without our natural world, soil, plants, animals, etc. there would be no life.

Keys to our farm are Family- Your family is the best team you could ever have; no-Till for 26 years; diversity in crop rotations, pastures, and livestock; rotational grazing since 2010; and providing habitat for wildlife. On our farm we use the 5 principles of soil health to help us manage our crop and rangelands: Minimal soil disturbance, diversity, integrate livestock, living roots as much as possible, and keep the soil covered.

Overgrazing and tillage destroy the soil's structure and the homes of all the organisms that live there. The soil organisms spend more time rebuilding the soil rather than nurturing the soil. A slake test is a real easy way to test your soils aggregate stability. The soil is our largest water filter and water quality is very important.

Diversity is important and all around us. We have diversity in jobs and foods we eat to help our world and bodies function properly. The same goes for our soil. Feeding the livestock below the soil is just as important as above. Animals and organisms need diverse food to stay healthy too! We have nematodes, arthropods, protozoa, fungi and so much more that work together to help our soil function properly. Worms are near the top of the soil food web food chain, if you have good worm activity you should have a fairly balanced healthy soil food web. We also have diversity in plants and roots. We have deep, shallow, fibrous, and tap roots that work together to bring up different levels of nutrients for plant use. If you look out into native prairie you can see many different types of plants thriving and complimenting each other. For our crop rotations we don't have a set rotation, but try to get through the different crop types (warm & cool season grasses and broadleaves) at least once in 5-7 years. We do our best to keep a 2 year gap between the same crops to break the cycle of disease and pests. It all depends on what the fields needs are and the weather conditions. Staying diverse helps keep weeds, disease, and pests better under control. A few crops we have in our rotation are: spring wheat, winter wheat, milo, peas, lentils, oats, millet, sunflowers, corn, flax, sudan, cover crops, garbanzo beans, chickling vetch, teff grass, and hay barley.

Integrate livestock- Livestock stimulate plant growth and fertilize by leaving feces, slobber, and urinate. The more diversity you have the more successful you can be as different animals graze differently and prefer different plants. Rotational grazing helps your pastures have better rest and recovery time. Grazing croplands can give you grass a break and will help you cycle your nutrients more efficiently. A benefit that goats give is when they eat the seeds they pass through their digestive tract and become sterile and will not re-grow. We are starting to use them as a tool to control noxious weeds especially around water areas. Our pastures have permanent perimeter fences and the majority of the cross fences that divide them down are portable electric fencing. This makes it easy to change the size of the pastures and move them some each year. We have also converted some cropland back to grass to improve our soil health with perennial root systems for a few years.

Living roots - The easiest food for soil organisms comes from the roots of living plants. The plants feed the soil and the soil feeds the plants. Living plants also mean that photosynthesis is taking place by the plants capturing energy from the sun and moving it i nto the soil.

Soil cover - Who would you rather be? A man in the hot sun or under the shade of the umbrella. I definitely like some shade. The soil feels the same way. Did you know that there is more living organisms in a tablespoon of healthy soil than people on our planet? Soil cover benefits are preventing erosion, preventing evaporation, keeping the soil cool on hot days, and providing habitat for organisms in the soil.

Experience is the best teacher. We have done several soil tests to learn about our soil with our family. One that stands out is the Tighty Whitey test. We buried 2 pair of white cotton underwear in the soil and left them for 30 days. One was buried with bare soil and no living roots. The other was buried under soil cover and had living roots on and around it. Our results were night and day difference. The biological activity that was taking place with the sample that had living roots and

soil cover was fantastic. The microorganisms ate almost all of the underwear except for the elastic band. They other sample had some holes eaten in it, but not much.

We want to help people understand that our soil is living and we need to take care of it and manage it properly no matter if you have cropland or grassland. We must have soil to have life. We have a fantastic network of people in our area willing to share their knowledge. Our NRCS folks, SD Grasslands Coalition, and SD Soil Health Coalition are fantastic mentors. Attending conferences, meetings, and visiting with new people have helped us continue to learn and make positive changes in our operation.

Slake Test - Left is a tillage field and right has been no-till for 26 years.

Tighty Whitey Test Results: bare soil and no living roots.

Tighty Whitey Test Results: living roots and soil cover!

FROM DAIRY TO PRAIRIE

Julie Mattox, Landowner/Ecologist

Tallgrass prairie restoration requires patience in the best of conditions; tallgrass prairie restoration on an old dairy farm will fully test that patience. I relocated to East Texas in 1996 to a home on one acre that was surrounded by my neighbor's 70-acre pasture that was once a dairy. At that time, this pasture was mainly introduced grasses with a few remnant native species and was set stock with grazing cattle. There were several species of wildlife and birds utilizing the property for nesting and wintering. Three years later, in 1999, this 70—acre property reopened as a small dairy milking 240 cows. The pasture became severely overgrazed and the wildlife soon disappeared. No native grassland birds, no insects other than flies, no snakes, only the occasional raccoon or opossum. European starlings and English house sparrows became dominate resident birds. All plant diversity was lost. In my home on the one acre, I was faced with three choices: live with the current conditions, move, or buyout the dairy farm. After several years of negotiations, I purchased the old dairy in 2011. The cows moved on. A few

immediate changes were in order: dairy lagoons were drained, a pond created and few tree islands planted. I continued to cut and bale the coastal bermuda hay until I had an aha moment in 2014. Leaning on a bale of hay, I closed my eyes and listened. I didn't hear anything. No birds chirping, no insects buzzing, just silence. With the monotypic stand of coastal bermuda, I had no habitat for our native wildlife. I had already been reading about prairie restoration for some time. I decided it was time to take action. I contacted Texas Parks and Wildlife (TPWD) for technical guidance. In the spring of 2015, my first 25 acres of property entered into the Texas Parks and Wildlife Pastures for Upland Birds program, followed by another 35 acres in 2016. Coastal bermuda was eliminated from the property and seeding began with the TPWD provided tallgrass prairie mix in January 2016. I soon began to see changes. Eastern meadowlarks, dickcissels and lark sparrows nested on the property for the first time, and the wintering birds exceeded my expectations. Numerous savannah sparrows, chipping sparrows, song sparrows, Harris sparrows, white crowned sparrows and many more I have not identified spent the winter on the property. Rabbits came back as well as plenty of other wildlife. The property sounded alive once again. I am continually amazed at the diversity of insects and hardly a day goes by without seeing a species I had never seen before. Of course, there have been many challenges in the process of restoring this old dairy back to tallgrass prairie. Research on the property suggests there had been a dairy farm in the location on and off since the 1940s. Areas where cows had been fed for years have not yet responded to the native grasses and forbs, mostly due to the cool season annual rye that overburden the native grasses. That first season also taught me about the seed bank of undesirable plants in the soil that had been suppressed for years under the bermuda grass.

We are working to eliminate the invasive species and to control the annual rye this year. We also began some small prescribed burns in the winter and early spring to remove additional biomass. In February, I began rotational grazing with 40 stocker cows. Small one to two acre pastures were created using hot wire fences to contain and move the herd. Cattle are moved every one to two days after eating the rye to about three inches to remove the biomass and give the natives a better chance to grow. In addition, we are broadcasting native grass and forb seeds in some areas and allowing the cattle to trample plant as the buffalo would have done many years ago. Thirty-five of the cattle were removed when the warm season grasses begin to grow leaving five cows and their calves that I have continued to rotationally graze. And just what was the turnaround once the rye had been removed by the cows? The native grasses and forbs have flourished. Big bluestem, eastern gamagrass, sand lovegrass, switchgrass and sideoats grama found growing in areas never before seen and stands of grasses growing in heavier where they had been growing years earlier. Forbs that I had seeded four years earlier and never observed before where found expressing themselves in many areas. The change was incredible. Maybe these forbs and grasses had always been there but covered by the annual rye. Possibly it was the reseeding I did in some areas or maybe it was the cool wet spring. It was some all of those things but I am led to believe it was the cattle that set the stage in motion for all of this to happen. I can no longer imagine a tall grass prairie restoration project without the use of cattle if properly grazed. The cows were the missing link in the equation. I now believe that the cattle, if rotationally grazed are as much a part of the prairie ecosystem as the grasses, forbs, insects and other animals. They are my buffalo. The cattle that were once my problem now are the solution.

3. GRASSLAND DEPENDENT WILDLIFE

NRCS WORKING LANDS FOR WILDLIFE 2.0 BOBWHITE IN GRASSLANDS INITIATIVE

Jef Hodges, National Bobwhite Conservation Initiative

The Natural Resources Conservation Service (NRCS) launched the Working Lands for Wildlife (WLFW) program in 2012, targeting 7 endangered species of national priority, with monarch butterflies added later. Since the inception of the program over 7.1 million acres have been enrolled in the program and has been proven to be successful. The WLFW conservation model has NRCS working with landowners to identify solutions to habitat issues that are compatible with producer and wildlife objectives, providing a win-win situation for both. The WLFW program is based on five tenants: Trust and Credibility; Shared Vision; Strategic Approach; Accountability and Leverage. Based on the success of the WLFW conservation model, NRCS expanded the program in 2016 (WLFW 2.0) to include state identified priorities. Bobwhite in Grasslands were among those new state priorities.

The National Bobwhite Conservation Initiative led the effort to establish the Bobwhite in Grasslands project. Eight states (AR, IL, IN, KY, MO, NC, OH, VA) originally joined the petition to establish a Bobwhite in Grasslands project, with 2 others (TN, MD) joining in at a later date. Interested states can join at any time. The nationally led WLFW projects carried additional, dedicated funding for the implementation of conservation practices, however the WLFW 2.0 do not. Projects are accomplished primarily through the Environmental Quality Incentive Program (EQIP). What WLFW 2.0 does bring to the table is the successful conservation model of collaboration with landowners, a strategic approach, accountability and leverage of funding. WLFW Bobwhite in Grasslands is targeting 150,000 acres.

The primary objective of the Bobwhite in Grasslands project is to replace endophyte infected tall fescue or other exotic forages with native forages and develop a wildlife friendly grazing plan with the landowner. There are also other supplemental practices available to improve the functionality of the site for livestock and bobwhites such as fencing, watering facilities, shrub planting, prescribed burning and others.

In support of this project, NBCI has contracted with NRCS to conduct a series of in-service training workshops for NRCS staff and other technical service providers to provide them with science based information about native forages. Participants are fully immersed in the details of establishment, grazing management, animal performance, economics, use in a complimentary system with cool-season forages and integrating with bobwhite and grassland bird habitat.

Since implementing this program we have encountered some challenges and are working to address them. Because there isn't any dedicated funding for the project, documenting practices and acres accredited to the program is inconsistent and difficult to track. Some projects are being recorded under regular EQIP or existing Regional Conservation Partnership Programs (RCPP). Additionally, some states have not established a coding option in their tracking system for WLFW Bobwhite in Grasslands. Landowner adoption of native forages has been slow and in rare instances there is local agency bias to overcome.

Due to the challenges related to tracking these projects and a lack of standardized tracking of native vegetation use in NRCS, it is difficult to get a clear picture of what is being accomplished. An educated guess, if for trend only, is made by looking at acres planted using the EQIP Forage and Biomass Planting practice. For the years 2016 – 2018 and definitively planted to native vegetation, in the 10 Bobwhite in Grassland states, 4,618.9 acres have been planted to native forage. This is likely very low due to only using acres accredited to EQIP and acres accredited to other programs and acres

planted to unidentified plant material but planted to native are not included in this total.

NBCI is continuing in-service training and producer workshops in 2020. NRCS is working on a solution to the project tracking issue. The Bobwhite in Grasslands project is being combined with a Bobwhite in Pine Savanna project to create one Bobwhite project and work is being done to elevate bobwhites to a national priority, which will bring dedicated funding.

GRASSHOPPER SPARROW DENSITY AND NEST SURVIVAL ON CONTINUOUSLY-GRAZED NATIVE WARM-SEASON GRASS PASTURES IN THE FESCUE BELT

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Eastern grassland bird populations have been declining for several decades due to the loss and fragmentation of native grassland habitats. Increased use of native warm-season grasses (NWSG) as summer forage for regional beef cattle operations may provide valuable habitat for grassland birds in the fescue belt, where cool-season grasses currently are predominant. A randomized complete block design experiment comparing Grasshopper Sparrow (GRSP) demographics among two continuous NWSG stocking strategies, continuous (CONT) and heavy-early (HEAVY), and a tall fescue (FESCUE) reference, was conducted from summer 2015 through summer 2017. Grasshopper Sparrow density was more closely related to landscape context than treatment, although it was greater in NWSG (CONT and HEAVY) than FESCUE pastures. Density was negatively related to the amount of pasture perimeter that consisted of woody edge. Nest survival was related to distance from nests to woody edges, but the direction of the relationship differed depending on site. Vegetation composition and structure also influenced both density and nest survival. Density was maximized when ground cover of forbs was approximately 14% and visual obstruction was approximately 11 in, both at the pasture-level. Visual obstruction at the nest site was positively related to nest survival. Grasshopper Sparrows selected (CONT) to nest in, or used in proportion to availability (HEAVY), NWSG pastures, and avoided FESCUE. Within NWSG pastures, GRSP selected nest sites with optimal visual obstruction (approximately 10 in) and low grass cover. The majority of pastures in the fescue belt are relatively small and surrounded by forested landscapes. Given this landscape context, the location of NWSG pastures appears to have a larger influence on density and nest survival of GRSP than stocking strategy. However, density of GRSP was greater in NWSG than FESCUE pastures, and because of nest-site selection for NWSG, these pastures also produced more nests and fledglings than FESCUE.

POPULATION RESPONSES OF NORTHERN BOBWHITE AND GRASSLAND BIRDS TO THE CONSERVATION RESERVE PROGRAM WITHIN THE NBCI COORDINATED IMPLEMENTATION PROGRAM

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Northern bobwhite *(Colinus virginianus)* and many grassland birds have declined for decades in agroecosystems. The National Bobwhite Conservation Initiative's (NBCI) Coordinated Implementation Program (CIP) is designed to provide a model for remedying bobwhite declines, and to-date 24 projects in 19 states exist. We studied a subset of these projects in Iowa, Kentucky, Missouri, Nebraska, and Ohio to determine the contribution of the Conservation Reserve Program (CRP) to CIP. We report population responses of bobwhites and grassland birds, during 2013-18, to vegetation structure, landscape characteristics, management, and distances at which CRP land features influence bird population dynamics. We provide recommendations for increasing efficiency of the CRP, for example, re-enrollment strategies, for meeting stakeholder objectives.

SUCCESS OF A GRASSLAND-BASED APPROACH AS THE FOUNDATION TO NORTHERN BOBWHITE MANAGEMENT IN THE MIDWEST

Frank Loncarich, Missouri Department of Conservation

Other Authors: Kyle Hedges and Tom Thompson, Missouri Department of Conservation

Management of northern bobwhite in much of the Midwest has long been based on an approach that mimics the small-scale farming practices of early 20th century America. Recently, biologists in Missouri have noted thriving bobwhite quail populations on large, grassland-dominated landscapes where emphasis is placed on restoring natural community function rather than bobwhite quail management *per se.* To better understand how best to manage bobwhite populations, we used radio-telemetry to compare quail breeding season dynamics on traditionally managed-sites versus grassland-based sites in southwest Missouri. We present results of a 5-year study that included over 1500 radioed-tagged birds and ~ 500 nest records. These results demonstrate that vital rates key to reproductive output, including nest success and adult survival, were higher on grassland managed sites.

FENCES REDUCE HABITAT FOR A PARTIALLY MIGRATORY UNGULATE IN THE NORTHERN SAGEBRUSH STEPPE

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Few studies have examined differential responses of partially migratory ungulates to human development or activity, where some individuals in a population migrate and others do not. Yet understanding how animals with different movement tactics respond to anthropogenic disturbance is key to sustaining global ungulate migrations. We examined seasonal resource selection of a partially migratory population of pronghorn (Antilocapra americana) in the Northern Sagebrush Steppe (NSS) of Alberta, Saskatchewan, and Montana from 2003–2011. We developed step selection functions (SSF) for migrant and resident pronghorn during the summer and winter at two spatial scales (second and third order), then integrated SSFs across scales into one map prediction across the NSS. Both migrant and resident pronghorn showed the strongest responses to natural and anthropogenic

features at the second order, and weaker responses at the third order. Selection responses of migrant and residents differed the most in response to normalized difference vegetation index (NDVI), topography, and anthropogenic features. Seasonally, selection for intermediate greenness (NDVI) was strongest in summer, whereas avoidance of roads strongly influenced winter resource selection of both tactics.

Despite the growing appreciation and call for greater attention to the impacts of fences on wildlife (see Jakes et al. 2018), there have been few direct studies that quantify fence effects on partially migratory ungulate populations. In particular, pronghorn are known to have difficulty in navigating fencing, especially if the bottom strand of barbed-wire is close to the ground (Figure 1; Jones et al. 2018).

Thus, a secondary objective of this study was to estimate pronghorn responses to fences and subsequent habitat loss from these features while accounting for responses to other resource use. Understanding how fences alter pronghorn movement and seasonal resource selection among migratory and resident animals may be key to sustaining (or restoring) pronghorn populations throughout their range. We used broad-scale fence layers from Southeastern Alberta (Seward et al. 2012) and Northern Montana (Poor et al. 2014). Fencing is a ubiquitous feature on the landscape and its potential effects on wildlife are often overlooked. For example, these developed layers in Alberta and Montana contained enough fence to circle the earth eight times. We applied two separate measures of fences at each scale to better biologically assess potential pronghorn scale-dependent responses to fences, which were fence density (second order) and the number of fence crossings (third order). These scale-dependent fence models allowed us to assess the relative effects fences had on seasonal selection patterns of pronghorn. Once a final top model was estimated for the entire NSS, we then refit this top model (the No Fence model) to the reduced study area (i.e. Southeastern Alberta and Northern Montana) where the fence covariate data were available and re-estimated the model accounting for the effects of fence density or the number of fence

Figure 1: A herd of pronghorn on winter range contend with barbed-wire fences, a common feature on the Western North America landscape. Photo: Paul Jones, Alberta Conservation Association.

crossings. These second sets of models with fence covariates were termed the Fence models. We tested for coefficient similarity between the No Fence and Fence models to ensure no confounding was caused by different spatial extents of the two analyses and then used the fence models to estimate indirect loss of habitat specifically from fences.

Both migrant and resident pronghorn showed strong avoidance of fencing at both spatial scales during summer and winter. Model predictions with complete removal of fences from the landscape (i.e., natural conditions) predicted an increase in the area of high-quality habitat of 16–38%. In contrast, doubling fence density on the landscape decreased the amount of high-quality habitat by 1–11% and increased low-quality habitat by 13–21% (Figure 2). Our results suggest that pronghorn winter and summer ranges can be improved by reducing the density of fences on the landscape, or mitigation measures to enhance fence crossings, to alleviate the indirect loss of habitat for this important endemic prairie species. Although difficult to measure, these indirect habitat losses can presumably result in population declines, as less habitat generally equates to a decreased ability to support larger numbers of animals. Such information is especially timely in the US because of the recent SO 3362 from DOI that directs agencies to conserve migration and winter habitat of pronghorn, mule deer, and elk in the western US. See link for the full article: http://onlinelibrary.wiley.com/doi/10.1002/ecs2.2782/full

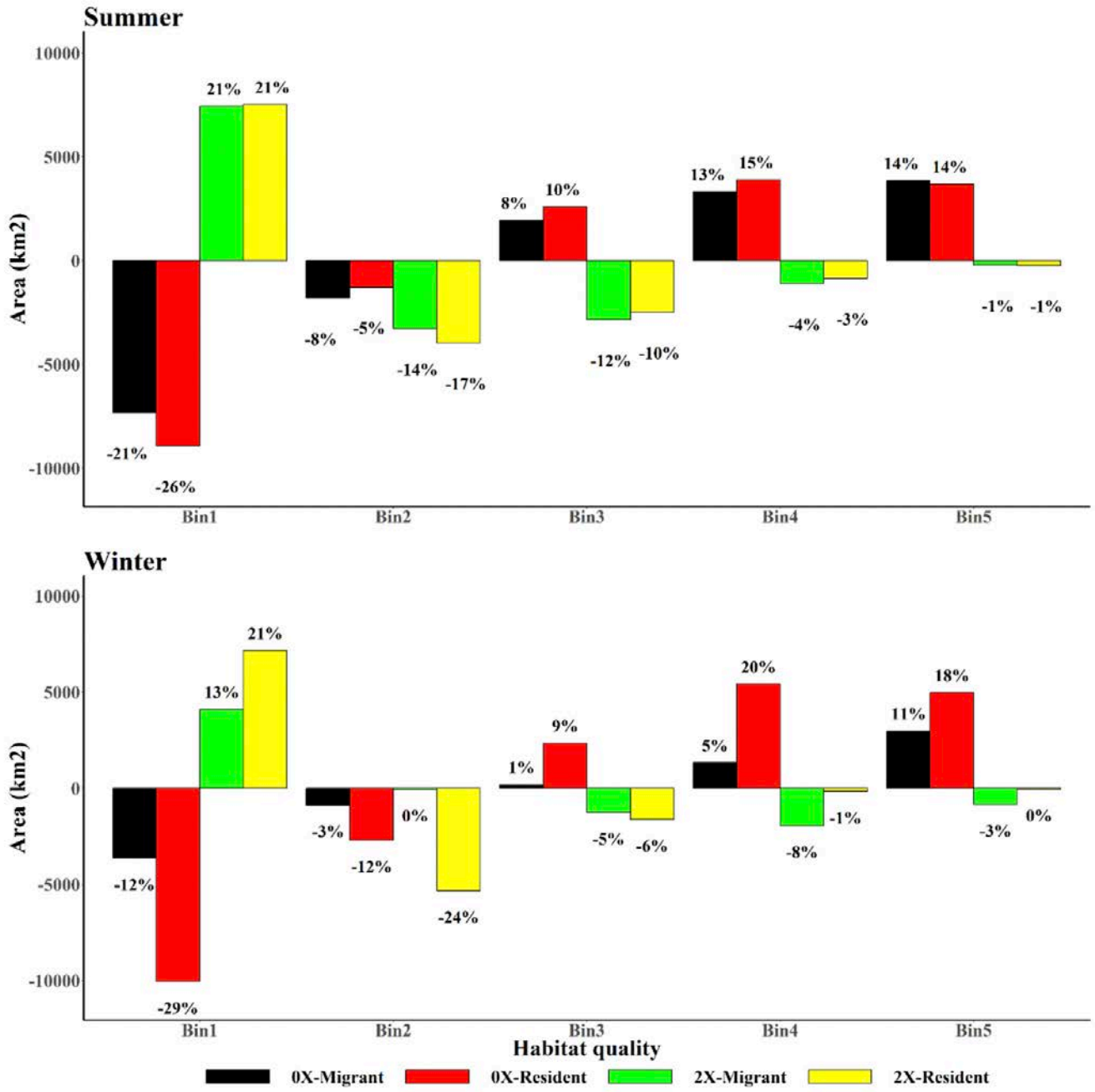

Figure 2: Predicted probability of selection change in area (km2) of bin 1 (low) to bin 5 (high) quality habitat for migrant and resident pronghorn during the summer (top panel) and winter (bottom panel) under two fence scenarios (no fences [0X] and doubling of fences [2X]) in the Northern Sagebrush Steppe, 2003–2011. Values below or above bars are the percent change for that category.

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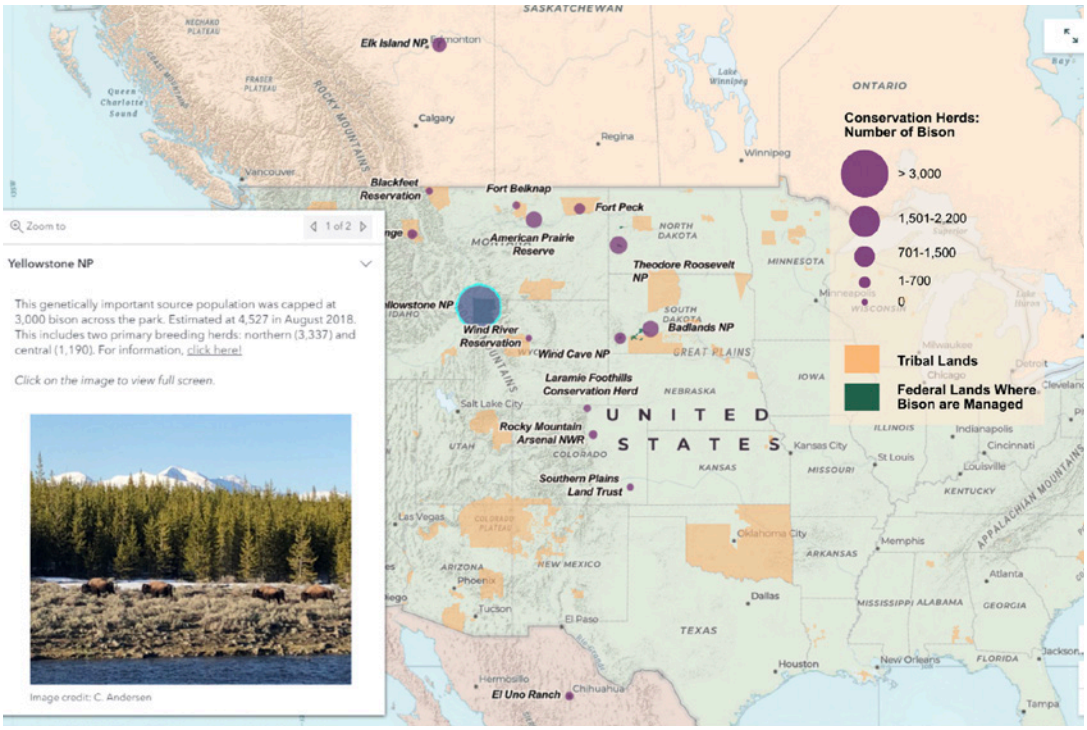
BISON MANAGED AS WILDLIFE: GIS MAP

Chamois Andersen, Defenders of Wildlife

Other Authors: Center for Conservation Innovation, Bison national parks and Tribal partners

Plains bison (bison bison) are being restored in conservation herds on tribal and public lands across the Great Plains. These herds play a significant role in the restoration of the species and toward creating a meta-population from Canada to Mexico, an objective of the U.S. Department of Interior and International Union of Conservation of Nature. Defenders of Wildlife, the InterTribal Buffalo Council and national parks and refuges with bison herds have partnered to generate a GIS-based map illustrating the conservation bison herds across the West.

This project includes a tool created for bison mangers to provide regular updates on herd size as well as the acquisition of lands secured for bison habitat in each location. This GIS platform will be used for inventorying each bison herd along with spatial analysis of lands that may be considered to better connect bison seasonal ranges. This map will be used for public and political outreach efforts, and featured as an interactive story map with videos, photos and other information on the herds and tribal/public bison programs. Layers of data will include original bison source herds as well as a tracking system visually displaying the transfer of animals to the various conservation herds.



DEVELOPING INNOVATIVE SOLUTIONS FOR HUMAN-BISON CO-EXISTENCE ACROSS NORTH AMERICA

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Other authors: Liba Pejchar, Jennifer Barfield, Becky Niemiec, and Lissett Medrano, Colorado State University ; Cynthia Hartway, South Dakota State University

Bison are an iconic and ecologically important species, but occupy less than 1% of their historic range (Sanderson et al. 2008). The reintroduction and management of bison are among the most challenging human-wildlife coexistence issues today in North America, yet there is widespread interest in restoring this iconic species across the American West (Sanderson et al. 2008). Public, private and tribal land managers have identified bison reintroduction as a priority to ensure viable free-roaming populations, restore ecological function, and enhance cultural values. Currently, reintroduction of free-roaming bison is fraught with concerns over the transmission of disease to livestock, competition with cattle for shared forage, and uncertainty about the ecological impact of bison on arid ecosystems (Sanderson et al. 2008, White et al. 2011). With support from Colorado State University, our team came together to explore the ecological, economic, social, and cultural dimensions of this timely and continental-scale challenge, and propose an agenda for research and action.

Activities

In May 2019, we hosted a two-day technical workshop that brought together 33 practitioners and scholars from the US, Canada and Mexico with expertise in bison reintroduction and management (Fig. 1). Through bringing together this diverse group of experts, the workshop served to address knowledge gaps in the management of bison including key policy, communication and research needs. Our working group identified that a stronger and more connected network of bison scientists and practitioners was greatly needed to facilitate bison restoration across North America,

Fig. 1. Themes from participants' vison for bison over the next 100 years. Bison drawing by Sharyn Davidson.

and suggested two different national-scale groups should form: 1) a bison working group consisting of scientists and practitioners to facilitate shared learning across diverse regions and contexts, and 2) a national advocacy and funding organization to increase social acceptance, awareness and interest in bison conservation. Our working group also identified thefollowing greatest research needs: 1) understanding which lands are most suitable for bison reintroduction given ecological and social constraints and opportunities, and 2) developing economic incentives for cross-boundary bison conservation across diverse stakeholders and landowners. Our workshop resulted in several working groups tasked with addressing these needs.

We also developed an online survey to reach a broader audience of bison experts with themes focused on the challenges, keys to success and research needs. The survey was sent to over 200 experts and we received approximately 80 responses, primarily from practitioners within the government, non-profit and academic sectors. Preliminary results found the top challenges to restoration to be social acceptability, political will, and ability to work across stakeholder groups. Top research needs included a need to better understand how to motivate support for bison reintroduction, where to focus efforts, and disease issues.

As a next step, we will submit a manuscript summarizing key needs, knowledge gaps, and future directions for bison reintroduction to a peer-reviewed scientific journal.

Acknowledgements

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4.GRASSLANDS AND POLLINATORS

ASSESSING LANDSCAPE SUITABILITY FOR POLLINATORS IN THE UNITED STATES GREAT PLAINS

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Conversion of native grasslands to other uses, primarily row-crop agriculture, has resulted in dramatic declines of many grassland-dependent wildlife species, including many species of butterflies, moths, and bees (Potts et al. 2010, Cameron et al. 2011); this has resulted in increased petitions to list various pollinators under the Endangered Species Act (USFWS 2019). Interest in pollinator conservation has grown substantially in recent years because of steep population declines of many species of grassland pollinators, but information to guide pollinator conservation is limited (Vanbergen et al. 2013, Landis 2017). We used pollinator biology along with principles of landscape ecology and metapopulation dynamics to develop a simple conservation decision-support tool that can serve as a general guide to landscape-scale pollinator conservation.

Even though pollinators are necessarily influenced by fine-grained habitat characteristics, such as density and diversity of floral resources, landscape characteristics, particularly patch size and inter-patch distance, can have a strong influence on pollinator occurrence, abundance, movement, community composition, health, and gene flow (Keyghobadi et al. 2006, McIntire et al. 2007, Dover and Settele 2009). Because conservation planning typically takes place at broad scales, we developed a tool based on patch size and inter-patch distances to provide a spatial framework for pollinator conservation in the U.S. Northern Great Plains.

We first assembled a spatial data layer depicting potential pollinator habitat, using data from multiple sources to ensure high classification accuracy and inclusion of small, isolated habitat patches typical of many relict grasslands important to pollinator conservation. We then classified areas within the landscape by size of grassland patches and distance to nearest patch of a given size. When applied to landcover data using a 5-ha threshold for patch size and a 500-m threshold for distance to the nearest 5-ha patch, the model output was consistent with areas identified as critical habitat for Dakota skipper *(Hesperia dacotae)* and identified potential areas for conservation and restoration. When used in conjunction with data showing risk of grassland conversion and location of protected lands, the model may provide additional context and information as the U.S. Fish and Wildlife Service evaluates individual pollinator species petitions for possible listings under the Endangered Species Act. In all cases, local management will be necessary to ensure that fine-grained features such as nectar sources and host plants are present.

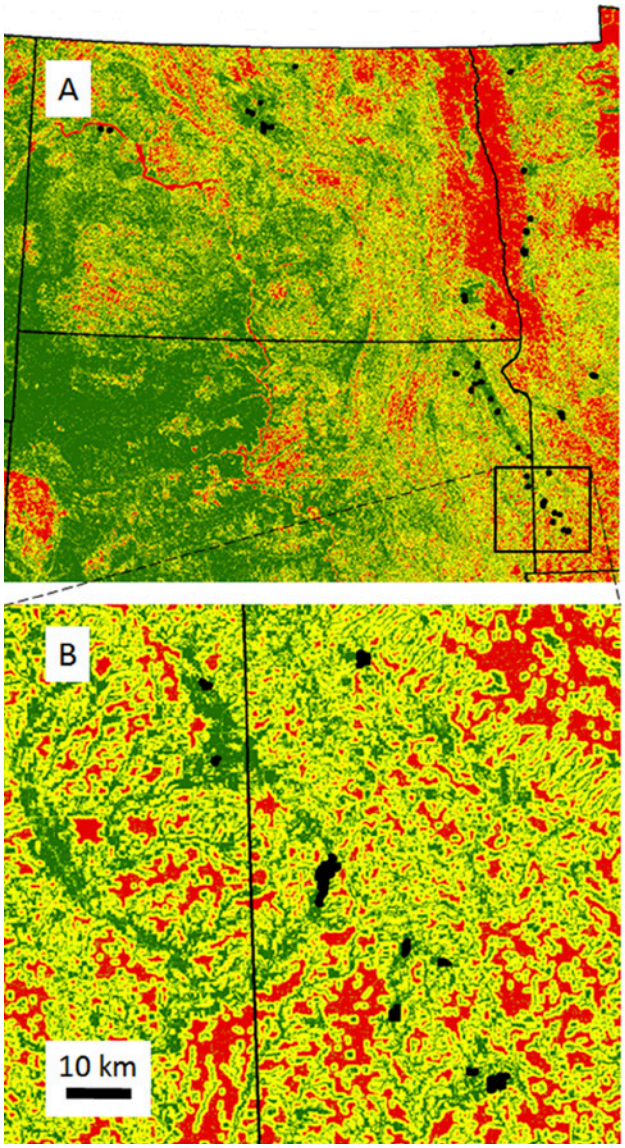

Figure 1. Areas designated as critical habitat for Dakota Skipper (black polygons) relative to landscape characteristics in North Dakota, South Dakota, and Minnesota (A). Areas designated as critical habitat for Dakota Skipper (black polygons) relative to landscape characteristics in inset portion of South Dakota and Minnesota (B).

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The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

RANGELAND MANAGEMENT PRACTICES TO SUPPORT POLLINATORS IN THE GREAT PLAINS

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Well-managed rangelands are important to pollinators because they provide the habitat pollinators need to survive and support pollinator species not found elsewhere. Rangelands evolved with natural disturbance processes such as bison grazing and fire. Today, rangeland that is not managed through grazing, haying, and/or burning is likely to become dominated by invasive or woody species and accumulate large amounts of litter and duff that hinder plant growth and seed germination, particularly for forbs and legumes that serve as food sources for pollinators. We outline best management practices on rangelands for pollinator conservation throughout the Great Plains and provide examples of implementation.

FIRE CAN POSITIVELY INFLUENCE BUTTERFLY ABUNDANCE IN MIXED-GRASS PRAIRIE

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Pollinators are in decline around the world due to a variety of interacting factors (Potts et al. 2010). The International Union for Conservation of Nature's Red List of threatened species shows 59 endangered or critically endangered species (Schultz et al. 2019). These imperiled organisms require conservation action, but often, management focuses on a single species, a single resource, or another aspect of land use entirely (e.g., cattle production). In order to conserve the butterfly community as a whole, researchers need to identify management strategies that meet the needs of multiple species, as well as those of the people who depend on the land.

In order for conservation to be effective for the northern Great Plains, we need to find ways for grasslands to also continue being productive for cattle producers. Over the last several decades, management has focused almost entirely on cattle while excluding fire. The Great Plains flora and fauna evolved alongside the interacting disturbances of grazing and fire, and decoupling these disturbances has had negative consequences, including woody encroachment and homogenization of the vegetation community (Fuhlendorf and Engle 2004). Our objective was to quantify the butterfly community across three treatments that vary in their spatial and temporal application of natural disturbances.

Our treatments included season-long grazing, which had moderately-stocked cattle for the duration of the growing season, and two versions of patch-burn grazing, which had the same grazing pressure in addition to different prescribed fire regimes. In one version of patch-burn grazing, we conducted one prescribed burn of 40 acres each spring. In the other, we conducted one prescribed burn of 20 acres each spring, followed by one prescribed burn of 20 acres each summer or fall, dependent upon burn conditions. To assess the butterfly community across these three treatments, we performed line-transect distance surveys on each 20-acre patch in all treatment pastures, for a total of 96 transects. We conducted three rounds of surveys in the summers of 2017 and 2018 in order to capture the community's phenology more completely. We also collected vegetation composition and structure data along transects adjacent to those used for butterfly

surveys. We then used composition and structure variables (percent cover of: Kentucky bluegrass, smooth brome, native C3 or C4 grasses, introduced C3 or C4 grasses, native or introduced forbs, native or introduced legumes, woody plants, litter or standing dead vegetation, and bare ground; total floral resource abundance, and visual obstruction as a measure of structure) to analyze each butterfly species meeting a total of ≥90 detections with a simple linear regression model.

Broadly, our study detected over 4,500 butterflies from a total of 42 species. We also counted nearly 92,000 stems of 128 flowering plant species. We did not see a difference in total butterfly abundance among the three treatments, but we did see differences within some individual species. Ten of our 42 species met the ≥90 detection threshold and we proceeded with analysis.

Five species that met the threshold did not show different abundances between treatments. The Common Ringlet did not show a significant response ($p \leq 0.05$) to any vegetation variable. The remaining four species varied in their responses. The Cabbage White showed a minimal response to litter cover. The Clouded Sulphur showed responses to all grass categories, as well as woody plants; differing from the closely related Orange Sulphur, which responded to both bare ground and standing dead vegetation. The Common Wood Nymph responded to all grass categories, litter cover, and standing dead vegetation.

We also had five species that did show different abundances between the treatments. Of these five species, all showed a higher abundance in at least one of the two treatments including fire as opposed to the treatment without fire. We had one species, the Meadow Fritillary, which did not respond to any measured variables. The other four species did respond. The Regal Fritillary, which is a species of conservation concern (Hammond and McCorkle 1983), responded to both native grass categories, as well as smooth brome. The Aphrodite Fritillary responded to smooth brome, both native grass categories, native forbs, and standing dead vegetation. Long-Dash Skippers responded to Kentucky bluegrass, smooth brome, native legumes, native and introduced forbs, woody plants, and standing dead vegetation. The Melissa Blue responded to smooth brome, native grasses, native legumes, native and introduced forbs, woody plants, standing dead vegetation, visual obstruction, and litter cover.

Most of the ten species that we analyzed did respond to at least one vegetation variable, but no species responded very strongly to any variable (all $r2 \leq 0.1$, even when $p \leq 0.05$). This indicates that these butterflies are reliant on many resources, which may be well provided by the heterogeneity patch-burn grazing creates. Further, not all species responded to the same variables. This implies that if managers aim to support a diverse butterfly community, they should not focus on one single resource, but should instead provide a variety of vegetation structure and composition.

No species showed a negative response to patch-burn grazing, in contrast to some previous studies of butterflies and fire. All species had equal or greater abundance in treatments including both fire and grazing as compared to the treatment with only grazing. North American grassland organisms evolved alongside fire and grazing, so the use of both disturbances likely provides an effect more similar to the historical landscape as compared to either grazing or fire alone (Anderson 2006). Mimicking a historical landscape may more fully provide resources for butterflies, as well as other grassland organisms.

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SURVEYING BEE COMMUNITIES AND THEIR ASSOCIATED RESOURCES ACROSS NORTH DAKOTA

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Native pollinator services are essential to global food security and the stability of native prairie ecosystems. Increasing pressures from human activities have led to a global decline in bee populations that threaten their contributions to both agricultural and natural systems. Monitoring studies have allowed researchers to detect rapidly declining populations by comparing historical to present data. However, the status of pollinator populations is still relatively unknown in many regions due to a lack of baseline data. The Northern Great Plains is among such regions that would undoubtedly benefit from increased native pollinator monitoring as the diversity and distribution of pollinator species across the region is relatively undetermined. Moreover, several species considered for federal listing also have distributions that may intersect the region giving further demand for spatially robust information regarding the status of pollinator species. We initiated a four-year survey of North Dakota pollinators to address the lack of current data on bee species across the state. We surveyed bee communities and their floral resources in each North Dakota county (53 total counties) at 3 separate grassland-dominated locations, twice a year, with two observers, totaling 636 surveys annually. Our survey sites incorporate grasslands managed by a combination of governmental, non-governmental, and private entities. We incorporate both active netting surveys and passive sampling through bee-bowls to sample communities more representatively. We also survey available floral resources and the plant community to relate vegetation composition and management to the bees captured at each site. We collected 10,330 bee specimens representing 187 species in our first sampling season in 2017 and are currently processing specimens captured in 2018. Our spatially extensive survey will represent bee communities from the diverse assemblage of grasslands within the region and will provide baseline information on the distribution of bee species required for future conservation planning.

CONSERVATION OF NATIVE PLANT-POLLINATOR INTERACTIONS IN NORTH DAKOTA GRASSLAND WORKING LANDSCAPES

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Human-induced global change has driven biodiversity loss so that we now require conservation intervention to sustain remaining ecosystem functions and services (Cardinale et al. 2012, WWF 2014). In grasslands managed for biodiversity as well as livestock forage services, it is essential to investigate the effects of grazing on production and ecosystem stability. Consideration for biodiversity should not be limited to species richness but also include the diversity of ecological interactions between species (Hammond 1995, Cardinale et al. 2012).

To further guide grassland conservation in working landscapes, we examined plant-pollinator interactions in the Sheyenne National Grasslands in the summers of

2015 and 2016. We then used a regression framework to evaluate the influence of floristic availability on pollinator abundance in our system. We found that the response to floristic resources differed between honeybees *(Apis mellifera)* and native bees. While honeybee abundance increased with exotic floral abundance ($z = 21.04$, $df = 182$, $P < 0.001$, $r2 = 0.53$), native bee abundance showed no relationship with floral abundance and instead was positively associated with floral richness in our system ($z = 4.85$, $df = 182$, $P \leq 0.001$, $r2 = 0.11$). This suggests foraging preferences differ between honeybees and native bees and could influence conservation and management strategies. Furthermore, it demonstrate a need to consider how management practices could influence bee communities differentially across the growing season.

We also used grassland butterflies to investigate differences between four grazing management practices (season long grazing, rotational grazing, rotational grazing with lowland mowing, and patch-bun grazing) in the same working landscape. We hypothesized grazing management practices would generate differing floristic resources that would thereby influence grassland butterfly community composition. To address our hypothesis, we sampled floral resources using belt transects and butterfly community and species level dynamics using line-transect distance sampling. We detected 2578 butterflies representing 34 species. Management practice was not a significant predictor of floral ($p = 0.319$) or butterfly community composition ($p = 0.604$), and sites under the same management showed dissimilarity in ordination space, indicating differences that may not be associated with grazing practices. At the species level, management explained density for six of nine butterfly species, but no individual management practice was optimal for a majority of detected species. Thus, over the timeframe of this study, grazing management practices did not generate differences in floristic community composition to drive community-level responses in grassland butterflies. Rather, management drove differences in individual species' abundance within the butterfly community, likely contributing to the butterfly diversity observed at a broader scale.

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UNDERSTANDING THE LINKAGE BETWEEN LAND-USE CHANGE, POLLINATOR HEALTH, AND POLLINATION SERVICES IN THE NORTHERN GREAT PLAINS

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The Northern Great Plains (NGP), a region often referred to as America's last honey bee *(Apis mellifera)* refuge, has undergone rapid land-use change due to bioenergy crop production and loss of conservation grasslands, thereby threatening forage lands for pollinators. We conducted a trend analysis and estimated Conservation Reserve Program (CRP) grassland to row crop conversion rates around honey bee apiaries from 2006 to 2016 and developed models to identify areas of forage loss. Our data showed NGP apiaries lost over 53% of lands enrolled in CRP, and the rate of loss was highest in areas of high apiary density. Our conversion analysis revealed over 402,000 acres of CRP in 2006 within one mile of apiaries was converted to row crops by 2012. Simulation models showed further reduction in CRP to 19 M acres nationally would reduce the number of apiaries in the NGP that meet defined forage criteria by 28% on

average. Alternatively, increasing the national cap to 37 M acres would increase the number of NGP apiaries that meet defined forage criteria by 155%. In addition, we presented a case study demonstrating how land-use change in the NGP has a direct effect on pollination services and beekeeper economics during almond pollination the subsequent spring. Our studies elucidate the consequences of past and future US Farm Bill policy on pollinator health and pollination services.

The research summarized in this presentation is available at:

Otto, C.R.V, H. Zheng, A.L. Gallant, R. Iovanna, B. L. Carlson, M.D. Smart, and S. Hyberg. (2018) Past role and future outlook of the Conservation Reserve Program for supporting honey bees in the Great Plains. Proceedings of the National Academy of Sciences of the United States of America 115:7629–7634. National Academy of Sciences. <http://www.ncbi.nlm.nih.gov/pubmed/29967144>. Accessed 17 Sep 2018.

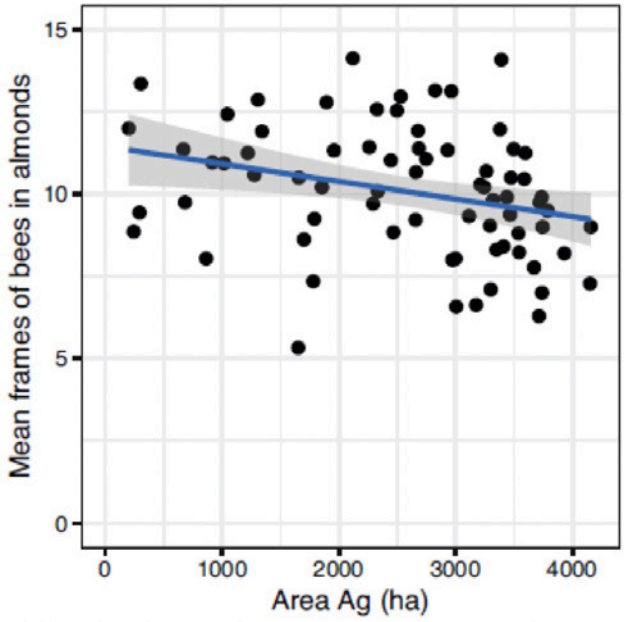

Figure: Relationship between the area (ha = hectares) of corn, soybeans, and small grains surrounding honey bee colonies in the summer and the sized of those colonies during almond pollination in California the subsequent spring. Figure used with permission from Smart, M. D., Otto, C. R. V, Carlson, B. L., & Roth, C. L. (2018). The influence of spatiotemporally decoupled land use on honey bee colony health and pollination service delivery. Environmental Research Letters, 13(8), 084016. https://doi.org/10.1088/1748-9326/aad4eb

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APPLICATIONS OF THE INTEGRATED MONARCH MONITORING PROGRAM

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Like many pollinator species, the eastern North American monarch population has declined by more than 80 percent during the last two decades (Semmens et al., 2016). Breeding range conservation has focused on enhancing milkweed host plants and nectar resources, as reduction of these resources is implicated in monarch population declines (Pleasants, 2017; Thogmartin et al., 2017). Current conservation efforts are driven by population targets and related national habitat goals, both of which have been developed using limited datasets and expert opinion. (Thogmartin et al., 2017b). Citizen science program data have been instrumental to modeling efforts and expanding general knowledge of monarchs, but are often concentrated near population centers and lack geographical balance. Furthermore, use of largely self-selected monitoring locations that often contain high-quality habitat (e.g., butterfly gardens) prevents robust statistical inference about average conditions or extrapolation to other

land-use types. Lastly, many programs record monarch locations opportunistically, without measured and repeated effort, making it difficult to identify long-term trends. A monitoring scheme that overcomes these limitations is needed to accurately track progress toward habitat and population goals, identify habitat deficiencies, and assess the success of conservation actions.

The Monarch Conservation Science Partnership (MCSP), a collaborative group of scientists addressing information gaps in monarch conservation and ecology, developed a strategy for monitoring conservation progress, starting with the end goal and working backward to determine the details. Through review of existing programs, 3 years of design meetings, and pilot testing, the strategy became the Integrated Monarch Monitoring Program (IMMP). The IMMP collects geographically and ecologically representative data using a stratified randomized sampling framework. Data from conservation sites, such as private lands enrolled in Farm Bill conservation programs, are included to provide insight into the effectiveness of management actions. The sampling framework optimizes statistical robustness while minimizing the number of samples needed by prioritizing sites where collecting information will be most valuable.

The IMMP has three primary objectives: to (1) track long-term changes in the distribution and abundance of monarchs and their habitats (2) provide geographically and ecologically representative information to fill data gaps and update current population and habitat models, and (3) acquire information about how habitat conservation actions affect monarchs and their habitat. Metrics include milkweed density, indices of blooming plant abundance, adult monarch abundance, egg and larval abundance, and egg and larval survival estimates.

The IMMP will greatly improve our knowledge of monarch biology, particularly in historically under-surveyed geographies and land-use types. The multi-dimensionality of IMMP data, which pairs quantitative habitat data with monarch use, provides an opportunity to assess how monarchs in several life stages interact with a variety of spatially and temporally explicit habitat characteristics. IMMP protocols can also be used to address priority research questions such as the location of gaps in nectar resources along migration routes, or how proximity to fields routinely treated with pesticides affects monarch recruitment and survival. IMMP nectar plant information can benefit broader pollinator conservation efforts and efforts for other declining species that rely on flowering plants (e.g., Rusty-patched Bumblebee). Data on nectar plant species richness and frequency can help land managers gauge progress toward habitat goals, such as establishing plants with staggered bloom times recommended by many pollinator plans.

Here, we highlight four examples of organizations and researchers who have used IMMP protocols to meet their information needs.

Midwestern Agricultural Conservation Lands: The Monarch Joint Venture partnered with the Natural Resources Conservation Service to assess the state of monarch habitat and monarch use on Conservation Reserve Program (CRP) lands in the Midwest during 2016-2017. While many efforts are underway to restore lands to native habitat, it is especially important that we monitor the progress and outcomes in order to use our conservation dollars most effectively and efficiently. In this study, the researchers used IMMP protocols to collect data on monarch habitat and monarch use of habitat in order to better understand the outcomes of conservation actions. Results from the study helped provide baseline habitat estimates and monarch occupancy for midwestern CRP lands and provided insight into seed mix design and species establishment trends (Lukens et al., in review).

National Fish & Wildlife Foundation (NFWF) Conservation Projects: The Monarch Joint Venture and the National Fish & Wildlife Foundation are working together to evaluate restored or enhanced projects funded through NFWF's Monarch Butterfly and Pollinators Conservation Fund. IMMP protocols were implemented to assess the quality of monarch habitat (milkweed and flowering plants) and monarch use of conservation sites in 11 states from Texas to Minnesota. The project can help us better understand the success of conservation funding and inform future conservation efforts.

Photo by Laura Lukens.

Grassland Restoration Incentive Program: The Rio Grande Joint Venture has used IMMP protocols to evaluate Grassland Bird and Pollinators Restoration efforts in Southern Texas. Researchers monitored restoration sites before and after best management practices specific to each site were implemented to measure change in habitat and use by pollinators. They were able to document increased desirable bird and pollinator plant diversity at the treated project sites.

Ohio State University: Researchers at Ohio State are using IMMP protocols to monitor rights-of-way habitat to examine the effects of management (such as annual mowing and selective herbicide integrated vegetation management) on vegetation and pollinator communities.

Many additional individuals, groups, and organizations are using IMMP protocols in similar ways. These include but are not limited to: Missourians for Monarchs, Monarchs Across Georgia, Pheasants & Quail Forever, USFWS, universities, private landowners, restoration practitioners, county conservation boards, the Department of Defense, the National Guard, and state DOTs. Broad and diverse participation is necessary to achieve the desired breadth and depth of sampling and to ensure the IMMP's long-term sustainability. Success will depend on mobilizing partners across government, academia, and NGOs, alongside a cadre of citizen scientists. These efforts are only just beginning, and the potential for long-term scientific payoff is enormous. Ultimately, monarch conservation relies on the cooperation of all stakeholders not only in protecting and restoring habitat, but also in understanding and evaluating this species and the habitats on which it relies.

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5. GRASSLAND BIRDS

BIRDS, HERDS, AND STEWARDS: SUSTAINABLE WORKING LANDS FOR THE FUTURE

Elizabeth Emeline, American Bird Conservancy

Throughout this America's Grassland Conference, we have talked about the importance of our grasslands and the indicator species that call them home. Each of us as individuals and organizations are coming together in some way to sustainably conserve our grasslands with the hope to continue to use and enjoy them well into the future. From those of us making decisions on the ground to researchers and those influencing policy, we all have a part to play when it comes to approaching grassland conservation.

For the American Bird Conservancy (ABC), our main approach is to conserve native birds and their habitats throughout the Americas. As an innovative organization, we use sound science and work in many partnerships to achieve our four goals.

1. To **build conservation capacity** by helping our partners and local communities build capacity to address the issues facing birds. This includes financial and technical support, knowledge sharing and technology development and implementation throughout many management and conservation programs.

2. **Eliminate threats** by finding solutions with policymakers and the private sector to address threats to birds that cause mortality. ABC has many programs focused on eliminating these threats. Some of the programs include reducing feral and pet cat predation, reducing collisions with windows, turbines, power lines and towers, and reducing pesticide and toxin deaths.

3. To **protect habitats** by working with landowners and partner groups to prevent birds of conservation concern from becoming endangered by improving the management of millions of acres of land in the U.S. and internationally.

4. Finally, working to **halt extinctions** of the most endangered birds by creating and sustaining protected areas that provide essential habitat for these birds (ABC, 2018).

The choice of conserving birds and their habitats is an obvious one since birds span across the entire planet. Birds are highly visible and easily identified; making them easy to observe and to gain knowledge about them. They are enjoyed by many for both their beauty and song, which has made them economically important. The love of birds has been undeniable even before the American naturalist and ornithologist, Roger Tory Peterson, became an inspiration for the environmental movement of the 20th-century. He stated, *"Birds are indicators of the environment. If they are in trouble, we know we'll soon be in trouble."* Birds typically reflect the health of their environment and can indicate whether an ecosystem is heathy or otherwise. We can then make assumptions about the health of the environment based on the abundance and diversity of birds in an ecosystem.

Specifically discussing grassland birds as a vital part of North American landscapes, there are forty-eight species that nest in the U.S. grasslands, including ducks, grouse, hawks, and song birds and one-third of all grassland bird species are on the watch list due to steeply declining populations and threats to their habitat (NABCI, 2009). Grassland birds are some of the fastest and most consistently declining birds in North America. Since 1968, the grassland bird indicator for twenty-four obligate breeding birds declined by almost 40%, but the decline flattened out beginning in 1990. This recent stabilization noted in the 2009 State of the Birds report continues today reflecting the significant investments made in grassland conservation. Data from

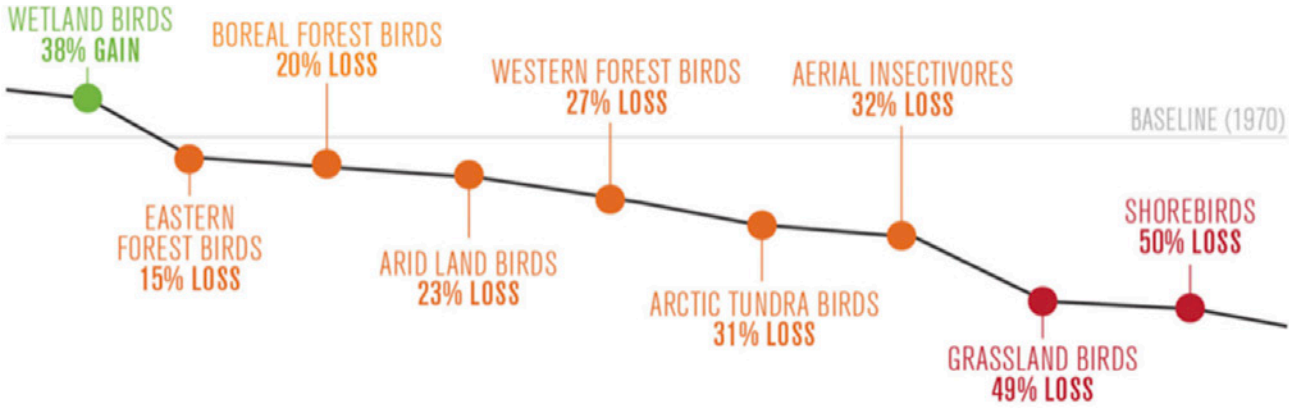

Figure 1. Status of Birds: The percent population change of all major groups of native and wild birds in North America since 1970.

Breeding Bird Surveys and Christmas Bird Counts since 1970 show that nearly all the major groups of native and wild birds in North America are significantly declining in population (Figure 1). The total loss of individual birds from the breeding population is nearing an approximate two billion loss as of 2017 (ABC, 2018).

So why work in the grasslands? Or rather why work with private landowners in the grasslands? The 2013 State of the Birds report highlighted how important private lands are to the different species guilds. It noted that more than 80% of the habitat for the twenty-nine grassland obligate birds is on private lands, the largest percentage of any habitat (NABCI, 2013). Most birds depend on sustainable management practices to meet their habitat needs. Livestock production is compatible with grassland bird management when grazing is managed in a way that creates diverse mosaics of grassland habitat beneficial to livestock and grassland birds.

ABC has identified *Birdscapes* or focus areas where conservation opportunities overlap with key habitats for birds. Then with the help of partners, we develop and implement management practices coupled with incentives to ensure that bird habitat is well protected, managed and conserved (ABC, 2018). There are many species that migrate from the Great Plains to Mexico's Chihuahuan grasslands, so while I am working here in the nesting and brood rearing habitat for many of these birds, we also have focus areas in Mexico that work in the major wintering grounds for these birds. They are working toward similar goals of conservation, building capacity and investing in livestock grazing and water infrastructure as are we here in the Northern Great Plains.

It was in 2013 that ABC decided to focus conservation efforts in these individual ecosystems. The flagship species for the Northern Great Plains became the Long-billed Curlew. They are easy to monitor due to their size and have an easily recognizable silhouette. Although Long-billed Curlews are not up for listing, they are on the decline and have seen success where sustainable management practices have been implemented. ABC's "Land Manager's Guide to Grassland Conservation and the Long-billed Curlew," outlines the practices that curlews respond well to, from grazing management to seasonal crop and agricultural practice timings (https://abcbirds.org/program/taking-flight/long-billed-curlew-grassland-birds/).

The best hope for birds and other wildlife is to use management practices that are compatible with the native species. Landowners that are agricultural producers working to manage both farmland and rangeland can obtain financial assistance to help fund the implementation of conservation practices (NABCI, 2013). Some practices can be funded through Farm Bill conservation programs (https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/) and may have an effect on bird populations. After years of declines, we have seen stabilization and, in some cases, an increase in bird populations after the introduction of key Farm Bill conservation programs (Figure 2; NABCI, 2017).

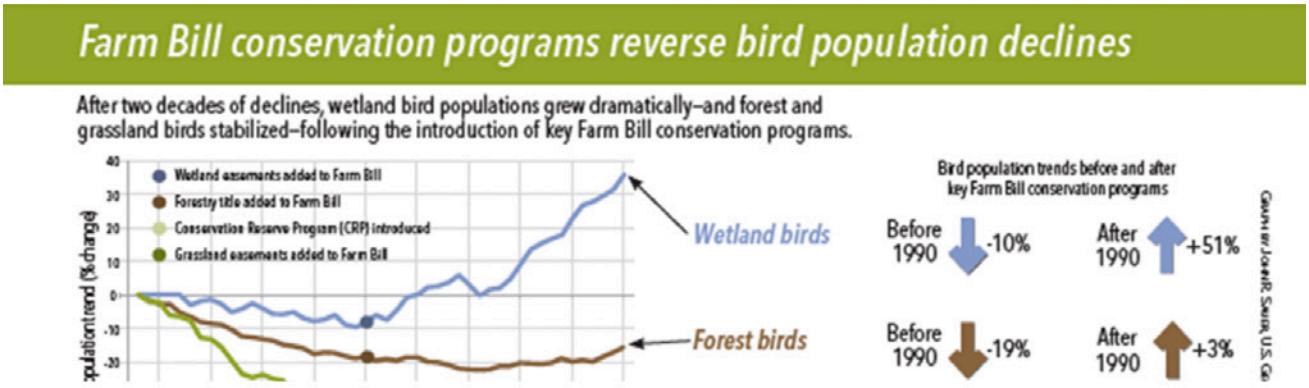

Figure 2. Farm Bill conservation programs and Bird Population Trends since 1965.

This leads into what I do as a conservation specialist but first a little back ground. I am from a small ranch near Broadus, Montana. I chose to come back to my home county because conservation and the landowners in my community will always be important to me. I work with the Natural Resources Conservation Service (NRCS) in the Broadus field office. I am available to talk with agricultural producers to promote land stewardship activities that enhance habitat for grassland birds while maintaining sustainable land use, to assist landowners by providing technical assistance, and to assist NRCS with implementing their conservation financial assistance programs. I've also been working with our Conservation District administrator on education programs in the school system and attending local talks and meetings to promote grassland conservation.

In addition to helping NRCS with their financial assistance programs, ABC may have financial assistance funding set aside to help landowners. The most recent project through ABC is a well development project. This project includes forested pastures with intermixed uplands of grassland habitat. Some areas remain un-grazed by livestock while others may be grazed quite heavily. This is due, in part, to lack of available livestock water. At this site, grassland birds like meadowlarks and sparrows are abundant. The new water development will improve distribution of cattle-grazing and allow the producer to use grazing as a management tool. The producer will be able to implement a rest rotation system between his forested pastures and his grassland pastures. This type of system allows for periods of rest and recovery for plant communities consisting of native plant species thereby improving or maintaining diversity, and the quality of habitat for grassland birds.

Small steps in the right direction for conservation can mean everything in the long run. This will benefit not just grassland birds but also private land owners that need the infrastructure to improve forage for their livestock. The decisions we make now to manage working lands sustainably will mean that hopefully the landowner's operation will last long into the future to see the prosperity of our small agricultural communities and our grassland birds.

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RESTORING QUAIL HABITAT ON WORKING LANDS THROUGH A TARGETED COMMUNITY BASED APPROACH

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Population declines of Northern Bobwhite Quail have been at the forefront of conversations between landowners and conservationists for several years. There are likely many factors that have contributed to these declines, but the effect of the continual loss and degradation of native grasslands cannot be overstated. The forbs and grasses associated with these communities are needed to sustain healthy ranches, livestock, and populations of wildlife. The United States Department of Agriculture (USDA) has developed many programs and practices in the last few years to help landowners improve quail habitat and grassland function on their properties. FSA and NRCS have developed programs and practices to help landowners plant cropland and other non-native grasslands back to native grasses and forbs. These practices are beneficial but can result in small patch size restorations. To make a larger impact on the landscape, we should also focus on two of our traditional NRCS grassland practices; prescribed grazing and prescribed burning. The acres of habitat restoration needed to make significant impacts on quail populations are in the 10's of millions. To accomplish that level of restoration, we must improve our working grasslands in the eastern US. Conservationists and landowners should collaborate to develop prescribed grazing programs that improve pastureland for livestock while increasing native plant diversity and usable space for quail. Prescribed grazing programs that include rotations and rest periods of pastures do just that. Many forms of rotational grazing or rest grazing systems have been developed around the country, each with degrees of positive impact on range condition and habitat. Allowing conservation professionals to work with the landowners to find the best fit for their operation will lead to the highest success. Increasing the adoption of prescribed burning in range and pastureland would have a significant beneficial impact as well. This practice is already used in many places to reduce brush and tree growth and improve range condition. Implementing prescribed fire with a frequency and seasonality that stimulates increased forb production could benefit grassland habitat. Using prescribed grazing and fire together in a patch burn grazing system has shown to be very effective in creating quality habitat in the year after a patch is burned and grazed. Examples of the effective use of this practice can be found throughout the central and southern great plains from Nebraska to Texas, as well as in Missouri and Tennessee. For quail, it is important for these efforts to be in a targeted area to have a landscape scale impact. These efforts work best when centered in community-based conservation. Identifying areas with producer interest and buy in is key to having success in these endeavors. The approach being used in Arkansas by The Arkansas Game and Fish Commission, the Natural Resources Conservation Service, and Quail Forever has been successful in large part to the producer groups in the targeted effort areas. The producers identified themselves as being interested in working on quail and grassland management and are the key to successfully implementing the programs. The development and use of new practices geared towards quail habitat is important, but we should also look toward traditional practices and implementing them with a shared goal of improving production and habitat. Doing so through community-based conservation can bring broader success of projects, and more buy in from local producers.

A FULL ANNUAL-CYCLE CONSERVATION STRATEGY FOR SPRAGUE'S PIPIT, CHESTNUT-COLLARED AND MCCOWN'S LONGSPURS, AND BAIRD'S SPARROW

Scott Somershoe, USFWS

Grassland birds are one of the most rapidly declining avifaunal groups in North America, with species wintering in the Chihuahuan Desert declining at the fastest rates. Sprague's Pipit *(Anthus spragueii)*, Chestnut-collared Longspur *(Calcarius ornatus),* McCown's Longspur *(Rhynchophanes mccownii)*, and Baird's Sparrow *(Centronyx bairdii),* are grassland-dependent songbirds of the Great Plains of Canada, the United States, and Mexico. These species breed primarily in the northern Great Plains and overwinter in the Chihuahuan and Sonoran deserts of the southwestern United States and northern Mexico. All have experienced significant population declines on their breeding grounds since the late-1960s, with annual population declines ranging from -2.1 to -5.9% per year from 1967-2015 and an overall population loss of 65-95% since 1970 (Sauer et al. 2017). Although the species are locally abundant in suitable habitat, overall population declines and range contractions have resulted in these species being designated as species of high conservation concern at national, state, and provincial levels in both the United States and Canada. The primary drivers of population losses are generally attributed to widespread conversion, both historical and contemporary, of native grasslands to agricultural production and other land uses. Degradation and fragmentation of remaining grasslands and management that is inconsistent with the needs of each species have also likely contributed to declines. Each of these drivers affects habitat at local and landscape scales, impacting the distribution, abundance, and reproduction of the species and ultimately resulting in consistent, long-term, and steep population declines.

Each of the four species have been considered for federal protections in the United States and/or Canada. Sprague's Pipit was petitioned for potential listing in the U.S. under the Endangered Species Act (ESA) in 2008, but the U.S. Fish and Wildlife Service (USFWS) determined listing was not warranted in 2015. In Canada, Sprague's Pipit was officially listed as "threatened" under Schedule 1 of the Species at Risk Act (SARA) in 2003. In 2012, Chestnut-collared Longspur was officially listed as "Threatened" under Schedule 1 of SARA. McCown's Longspur is currently listed as Special Concern under SARA. Most recently, Baird's Sparrow was officially listed as a species of "Special Concern" under SARA in 2017. The Species are protected as migratory birds in Mexico under the U.S. Migratory Bird Treaty Act (MBTA), but none of the Species are currently included in the federal "NORMA Oficial Mexicana NOM-059-SEMARNAT" (NOM-059) species-at-risk list in Mexico.

The four species also have been identified by the USFWS as Birds of Management Concern, which is a subset of species protected under the MBTA that pose special management challenges due to declining populations, small or restricted populations, and/or dependence on restricted or vulnerable habitats. Sprague's Pipit is designated as a focal species in the USFWS's "Focal Species Strategy for Migratory Birds," which was initiated to provide explicit, strategic, and adaptive sets of conservation actions required to return or maintain species of concern at healthy and sustainable population levels.

The USFWS, Canadian Wildlife Service (CWS), and many state and provincial governments recognize the concerns for the species and have identified them as conservation priorities. This conservation strategy was developed in collaboration with diverse partners who have jurisdiction and/or are stakeholders in management and conservation of these species throughout their annual cycle. The strategy provides a comprehensive assessment of the state of the knowledge of the Species and identifies priority research needs and conservation actions. It is intended as a guiding document for researchers, conservation planners, resource managers, and funding organizations to facilitate effective and efficient conservation of these species at a continental scale.

Our overarching purpose is to summarize the current knowledge of the life history and demographic parameters across the full annual cycle of each of the species in order to improve their population status. We use this information to identify gaps in our knowledge and prioritize monitoring and research needs that can help fill these gaps. Based on our current knowledge, we identify and prioritize critical conservation action required to reduce and reverse population declines with an additional goal that landscapes can support sustainable populations at desired levels.

Action proposed in this strategy can help prevent additional federal level listings under the ESA in the United States, SARA in Canada, and NOM-059 in Mexico, and ultimately remove species from lists of species of conservation concern due to recovery or improved status. For more information, see Somershoe (2018).

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GRASSLAND BIRDS AND LIVESTOCK: FINDING COMMON GROUND IN THE NORTHERN GREAT PLAINS

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Populations of grassland birds in North America are undergoing steep, continued population declines (Peterjohn and Sauer 1999). Evidence indicates that these declines are driven primarily by habitat loss, chiefly conversion of grasslands via tillage. Numbers of beef cattle in the United States are also declining from a peak in the 1970s. Declines in U.S. cattle numbers are driven by multiple factors, including foreign competition, reduced demand due to changes in consumer eating habits, government farm support for row crops, and lower profitability of cattle raising relative to production of row crops (Marsh 2003, GAO 2007). Lower numbers of beef cattle in turn reduce the need for grassland to provide forage for cattle, which likely affects availability of habitat for grassland birds.

We examined spatial and causal relationships between numbers of beef cattle and grassland birds in North Dakota, South Dakota, and Nebraska, U.S.A. Cattle numbers (specifically beef cows) were taken from 2012 county-level data collected by the U.S. Department of Agriculture in 2012 (National Agricultural Statistics Service 2019). Bird numbers were estimated from spatial models developed using data from the North American Breeding Bird Survey (Sauer et al. 2013) that link bird observations to environmental predictors and provide spatially explicit estimates of bird occurrence (Niemuth et al. 2017). The county-level population index for all six species of birds that we evaluated (grasshopper sparrow, lark bunting, Western meadowlark, upland sandpiper, chestnut-collared longspur, and Sprague's pipit) was positively and strongly correlated with cattle numbers in each county, demonstrating that cattle and grassland birds literally occupy common ground.

Correlation does not mean causation, and correlated numbers of birds and cattle were undoubtedly a function of the area of grassland in each county. In many

instances, grassland exists because local producers use the grassland for raising cattle, and these grasslands provide habitat for grassland birds. Economic pressures to convert grasslands to cropland are high (Marsh 2003, GAO 2007), and the U.S. Fish and Wildlife Service (Service) has a variety of programs to maintain grassland on the landscape and benefit wildlife by assisting private landowners.

In the Prairie Pothole Region of North Dakota, South Dakota, Montana, Minnesota, and Iowa, the Service has a program to purchase voluntary perpetual easements from landowners that protect grasslands from conversion. Easements are purchased from willing landowners, who are able to graze and hay the land, which is ideally suited to production of livestock and grassland birds.

In addition, the Service's Partners for Fish and Wildlife (PFW) program has tailored a suite of conservation practices that strive to simultaneously support grassland stewardship, bird conservation and ranch profitability. Most typically, the PFW program works with landowners to install grazing systems, which improves habitat for grassland birds, and create wetlands, which provide habitat for waterfowl, waterbirds, and shorebirds. In addition to providing wildlife habitat, these efforts also strive to improve profitability for landowners, and are accompanied by an agreement to keep the affected land in grass for 10 years. In many cases, these 10-year agreements often lead to a decision by a landowner to install additional conservation practices on adjacent pastures. Over the past 25 years the PFW program has partnered with more than 6,000 landowners throughout the Dakotas to enhance and restore grazing lands. Much of the money for these programs comes through Duck Stamp funding, as well as other programs that are supported by hunters, birders, and conservationists. All these efforts are voluntary, and provide incentives for landowners that help keep grass on the landscape for the benefit of livestock and wildlife, as well as the constituencies that use both.

Acknowledgments

We wish to thank the many volunteers who run BBS routes, as well as landowners who keep their property in grass. The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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6. GRAZING MANAGEMENT AND DECISION-MAKING

BARRIERS TOWARDS ROTATIONAL OR MANAGEMENT INTENSIVE GRAZING PRACTICE: VIEWS OF NON-ADOPTERS FROM U.S. GREAT PLAINS

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Ranchers who practice rotational (RG) or management intensive grazing (MIG) have experienced its benefits in multiple ways such as restoration of ecological conditions, increased livestock stocking capacity, and improved ranch profits (Becker et al., 2017; Roche et al., 2015; Ferguson et al., 2013; NRCS, 2006). Despite the widely recognized benefits, the adoption rate of RG or MIG grazing has declined in recent years. According to USDA National Agricultural Statistics Service Census of Agriculture (nass.usda.gov/AgCensus), the number of operations in the United States that practiced 'rotational or management intensive grazing' were 388,912 in 2007, but dropped more than 30% to 288,719 and 265,162 in 2012 and 2017, respectively. To understand the reasons underlying the declining adoption rate, we surveyed 4,500 ranchers from North Dakota, South Dakota and Texas. Our goal is to identify the major challenges faced by non-adopters of RG or MIG grazing and the factors that affect these perceived challenges. We asked producers to rank potential adoption barriers, as listed in Table 1, which can be summarized into three major categories, namely: 1) cost and labor constraints; 2) ranch condition constraints; and 3) knowledge and perception constraints.

Producers can choose the following options for each of listed barriers, namely 'not a challenge', 'minor challenge', 'some challenge', 'quite a challenge' and 'great challenge', denoted by 1 to 5 respectively. Water sources, labor and management time, and high installation cost were identified as the top three barriers towards adoption by non-adopters in both Dakotas and Texas. While perceptions towards the listed barriers are in general comparable among non-adopters in Dakotas and Texas (Figure 1), Texas ranchers regard weather as a significantly greater barrier when compared to their Dakota counterparts. For ranchers in the Dakotas, water source and labor time were greater barriers than high installation cost. These findings imply that besides monetary subsidy programs, educational programs and technical support tailoring towards specific needs in different regions are vital to address non-adopter concerns and to enhance the adoption rate.

Non-adopters generally consider knowledge and perception barriers to be less important than the cost and labor barriers, and the ranch condition barriers. However, lack of knowledge and mis-perceptions may lead to non-adopters' over-perceptions about other challenges to rotational grazing. For example, non-adopters regard extra labor as one of the top barriers for rotational grazing adoption. It has been advised by rotational grazing experts that the extra time required by rotational grazing is minimal if paddocks and fencing are efficiently designed (Undersander et al., 2002). In addition, RG or MIG grazing has the potential to save hay-feeding time due to increased grassland productivity. In this regard, educational ranch tours

might be highly effective for non-adopters to develop the right expectations towards the rotational grazing practice.

We found that among the non-adopters, those with the following ranch conditions are likely to perceive lower barriers to RG or MIG adoption: 1) soil of higher quality that can generally support higher stocking capacity; 2) farms with more acres of grassland or with more percentage of grassland; and 3) a higher percentage of owned grassland. Therefore, to help enhance the adoption rate of RG or MIG practice, ranches with such characteristics may be an ideal target group for more effective educational programs and focused technical support. Target group ranchers, once adopt the practice, could potentially influence other neighborhood ranchers through peer influence (Läpple and Kelley, 2013; Toledo et al., 2013).

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Table 1: Potential adoption barriers towards rotational grazing

Constraint domains	Listed barriers
Cost and Labor	High installation cost
	Cash flow constraints
	Labor/management time constraints
Ranch Condition	Water source constraint
	Weather/climate factors
	Lease Agreement restrictions
Knowledge and Perception	Lack of information/education/ support
	Uncertain Outcomes
	Unwillingness to take on leadership in new practices adoption
	Unfavorable neighborhood opinions

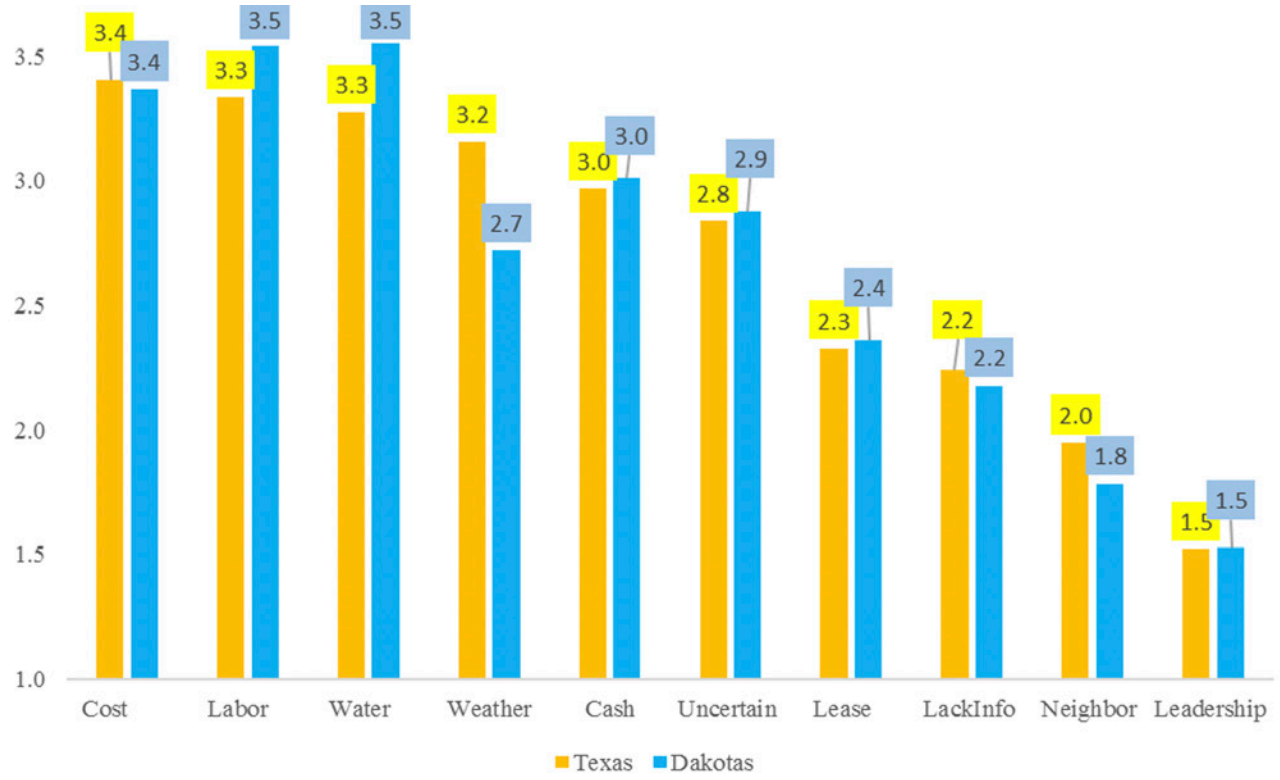

Figure 1: Non-adopter perceived barriers towards rotational grazing: Dakotas vs. Texas

UNDERSTANDING GRAZING MANAGEMENT INTENSITY CHOICES ON THE U.S. GREAT PLAINS

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Ruminant grazing systems differ in how grass is presented to the animals. At one extreme is continuous grazing, where a herd is put on one grassland unit for the grazing season. Alternatively, the land can be partitioned into N paddocks and the herd can be rotated over these paddocks. If N is relatively small and the herd remains on a paddock for weeks or months before moving to the next one, then the approach is referred to as rotational grazing (RG). In contrast, management intensive grazing (MIG) involves a large number of paddocks, usually 20 or more, moving cattle on a more frequent basis, usually between 1 to 7 days.

Rangelands cover a large proportion of earth's ice-free land and provide important reservoirs of biodiversity and major sources of ranchers' income (Crawford et al., 2019). Grazing systems, if managed properly, can provide substantial positive environmental and economic impacts. Rotational grazing presents the animals with more uniform, succulent grass and forces them to be less picky (Teague et al., 2015; Wang et al., 2018), whereas animals grazing extensively congregate near shade and water. Damaged, erosion-prone patches where invasive species can enter are avoided in more intensively management grazed systems. The resting grass can extend its root system deeper, ensuring greater drought resilience. There are also positive nutrient use and land use displacement implications. When the legume mix is high, given the even grazing and consequent distribution of manure, minimal additional fertilization is required and nutrient uptake

is improved so that nutrient runoff is less of a concern. Moreover, production per unit land increases with grazing management intensity so that nutrient inputs and greenhouse gas (GHG) emissions decline per unit beef output (Searchinger et al. 2018). Finally, if more intensively managed grazing can be found to improve profit from ranching and so support grass-based agriculture over land conversion to row cropping, then many environmental concerns will be avoided such as erosion, runoff, GHG emissions and grassland ecosystem habitat loss.

United States Federal government agencies promote grazing, including RG and MIG. The U.S. Fish & Wildlife Service provides technical support for and administers grassland easement programs that compensate farmers who commit to grazing in perpetuity. Conservation non-profits support similar working grassland schemes. In 2015, the USDA adapted components of the Conservation Reserve Program to support working grasslands, including RG and MIG, through rental payments and cost sharing subsidies for fencing and watering infrastructure.

Despite the potential benefits and despite various efforts aimed at promoting adoption, U.S. Census of Agriculture data reveal that the number of ranchers using RG/MIG has been declining and the adoption rate decreased from 47.9% in 2007 to 33.8% in 2017. Investigating the reasons behind this phenomenon and better understanding the decision mechanisms underlying ranchers' grazing adoption choices is important in light of the aforementioned environmental concerns and the need for viable grassland agriculture infrastructure to support ranching activity in the area.

Many studies have studied the factors that affect ranchers' grazing adoption decisions. RG and MIG systems require significant infrastructure investments, including fence and water investments to each paddock. Windh et al. (2019) report that additional infrastructure costs associated with implementing an RG system include one-time capital expenses, opportunity costs in terms of time value of the money expended on the infrastructure and reoccurring maintenance costs. Gillespie et al. (2008) state that the disadvantages of RG include initial capital expenditures and greater investment risks.

Another factor that affects adoption is differences in labor and time requirements. Compared with continuous grazing, RG is more time intensive due to additional time required to move livestock among pastures and maintain the additional infrastructure (Gillespie et al., 2008; Windh et al., 2019). The financial benefits of RG will need to outweigh these additional costs if ranchers are to switch from continuous grazing to RG (Crawford et al., 2019).

In addition, social interaction has been shown to be important for technology diffusion patterns (Hall and Khan 2003). With respect to grazing systems, Manson et al. (2016) conclude that while social networks are important for RG adoption, their effects differ according to how a rancher connects with other people, i.e., whether they are in a formal organization or are well known to one another by personal relationships. Nelson et al. (2014) find that information exchange is crucial to system transformation from traditional management to RG within dairy production.

Our paper uses a survey to better understand the factors affecting RG and MIG adoption decisions especially focusing on social networks.

Data and Research Methodology

In early 2018 we sent out a survey (supported by a USDA NIFA grant) to beef operators in 49 counties in North Dakota and 58 counties in South Dakota, as well as 81 counties in Central and North Texas, see Figure 1. The areas were chosen to allow a better understanding of how diverse grazing circumstances in the Great Plains affect choices of grazing practices. The survey made queries about grazing management practices, farm resources, motives, preferences and demographics. The response rate was 20.6% and 875 useable responses were obtained.

The questionnaire asked participants to specify their adoption status of RG and MIG. We divide the ranchers into two groups, i.e., RG/MIG adopters and non-

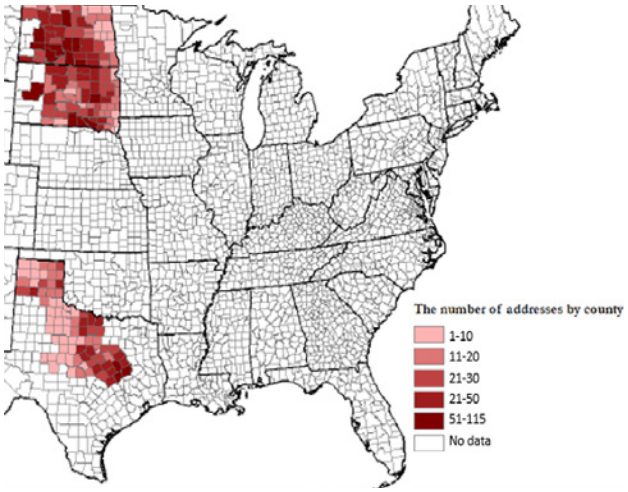

Figure 1. Selected survey counties of Dakotas in the Northern Plains and Texas in the Southern Plains.

adopters, based on their responses. Adopters were asked to consider their likelihood of further increasing grazing management intensity. Non-adopters were asked to choose the likelihood of adopting RG or MIG in the future. For each of the above possibilities, the respondents were given five choice options (1 = very unlikely, 2 = unlikely, 3 = somewhat likely, 4 = likely and 5 = very likely). Non-adopters were also asked to indicate their willingness to adopt RG or MIG (1=Yes, 0=No or Not Sure), as measured by acceptance or rejection of different hypothetical one-time subsidy values ($10/acre, $30/acre, $50/acre and $70/acre).

We also collected the information about rancher and ranch characteristics, such as operation years, education, loss ratio, ranch size, and internal fence status. Moreover, respondents were asked to provide their perceptions about how their labor and management time and economic profits were affected by RG and MIG choices. Both adopters and non-adopters were asked about how well they understood RG and MIG before adoptions. In addition, farm address data allows us to collate survey information with public domain land quality and other related information from farm neighborhoods, including land capability classification (LCC) and slope as obtained from the SSURGO database maintained by the USDA's National Resources Conservation Service.

Our main interests are to understand: 1) who adopts RG or MIG systems and why; 2) among the 60% who have adopted at any management intensity level, who are more likely to choose greater intensity level in the future and why; 3) among non-adopters, what are the potential drivers for further RG or MIG adoption; 4) what are the roles of social networks in understanding answers to the above three questions. Analyses in pursuit of objectives 1 and 2 are conducted using logit and ordered logit regression methods. Analyses in pursuit of objective 3 are conducted using financial investment analysis and discrete choice methods. Analyses in pursuit of objective 4 involve measuring social networks by three indicators: the number of adopters each rancher knows, neighborhood adoption rate, as well as the valuation of association information, e.g., whether information exchanges in some ranchers' associations are important to ranchers' decision making. County average numbers of RG or MIG adopters are obtained from National Agricultural Statistics Service (NASS). Versions of these indicators are included in the aforementioned regression analyses.

Results and Analysis

Results for our first research question show that ranchers who know more RG adopters tend to adopt RG or MIG, and so supports the Manson et al. (2016) conclusion that RG adoption is dependent on social landscape features including number of dairy households. Also ranchers who regard association information to be of comparatively greater importance are more likely to adopt, which is consistent with the findings in Nelson et al. (2014) that information exchange is an important factor for switching to RG. Moreover, ranchers with fewer operation years, higher education levels and better knowledge about RG or MIG are more likely to adopt more intensive management grazing.

When it comes to likelihood of increasing management intensity levels among current adopters, social networks also play an important role. If ranchers perceive lower profit from RG and greater profit

from MIG, then they would like to switch from RG to MIG, or to choose higher management intensity levels in the future.

For non-adopters' likelihood of RG adoption, social networks, fewer operation years, and the stock of pre-existing internal fences are factors that promote adoption. We find evidence that perceived greater profit from RG would encourage adoption. Additionally, ranchers with lower liability ratios, suggesting greater capacity to borrow from lenders, are more likely to invest in RG in the future. Regarding MIG adoption, non-adopters pay more attention to perceived labor requirement and initial investment costs.

Finally, Figure 2 shows that the percent response in willingness to adopt when a one one-time subsidy is increased by 1% is itself slightly below 1%, i.e., there will be just under 1% increase in the fraction of RG adopters for 1% increase in one-time subsidy and the response is strongly significant.

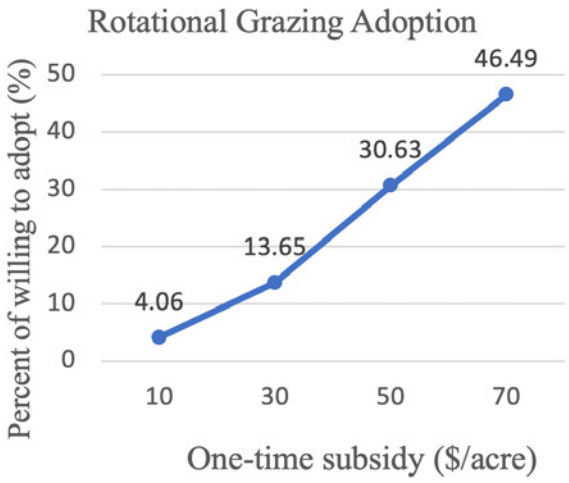

Figure 2. Non-adopter willingness to adopt in response to a hypothetical one-time subsidy.

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CONVERTING CROPLAND TO GRASS: THE ROLE OF MANAGEMENT INTENSIVE GRAZING

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Other Authors: William R. Teague, Texas A&M AgriLife Research, Vernon, TX; Urs Kreuter, Texas A&M University

1. Utilizing marginal land for grazing purpose, in comparison to cropping, generates higher environmental and ecological benefits. For example, conversion of annually cropped land to perennial grass/legumes can result in higher rates of carbon sequestration (Eagle et al., 2012). On the contrary, converting grassland to cropland, even in the absence of tillage, significantly decreases soil carbon (Dupont et al., 2010). In magnitude, loss of perennial grassland is also associated with many other negative consequences, which include more soil erosion potential (Pimentel et al., 1995), downstream water pollution (Faber et al., 2012), and loss of wildlife habitat (Lipsey et al., 2015).

2. Due to the numerous benefits generated by a well-maintained perennial grassland, it is in the best interest of government programs to promote the cropland to grassland conversion. Many cost share programs are available to help producers offset their initial investment cost. For example, NRCS promotes cropland conversion to perennial grass-based agriculture and conservation forage and biomass planting. For farmers to receive subsidy, cropland conversion to grass-based agriculture should be accompanied by rotational grazing practice, to help ensure moderate use followed by adequate plant recovery and root development of newly established forage plants. Several cropland to grassland conversion cases has been documented recently, which has been made possible with a portion of upfront conversion cost being compensated by government cost share programs (Millborn Seeds, 2019).

3. To provide agricultural producers with sustainable incentives to use their marginal land for grazing purpose, on top of the government subsidy support, it is important for the relative profitability of grassland to increase. Management intensive grazing (MIG) provides a great option to increase grassland profit by increasing soil health. On erosive land with poor crop yield potential in Missouri, Moore and Gerrish (2003) found that MIG systems provides greater net returns than those from cropping systems.

4. Our paper examined the role of MIG adoption on farmers' land conversion decisions using farmer survey data collected from North Dakota, South Dakota and Texas. For each state, 1500 ranchers were selected using proportional random sampling methods. In total we received 875 completed survey questionnaires, which represented 20.6% of the eligible survey sample of 4,250. Inquiring producers on their land conversion intentions, we found 35% and 30% of producers in the Dakotas and Texas respectively indicated willingness ('somewhat likely', 'likely', or 'very likely') to convert cropland to grassland in the next 10 years (Figure 1).

5. While other factors affecting farmers' land conversion decisions generally differ for respondents in Northern and Southern Great Plains, a common factor that significantly affected cropland to grassland conversion intention in both regions was the grazing management intensity. On average, we found continuous grazing users on average expressed that they were unlikely to convert cropland to grassland in the next 10 years. Ceteris paribus, we found rotational grazing (RG) users are more likely to convert their land from crop to grass than those using continuous grazing, while those using MIG practice indicated the greatest likelihood of conversion.

6. In addition, farmers' personal connections with RG and MIG users also significantly increase their future likelihood of converting cropland to grassland. Our findings implied that higher profitability associated with greater grazing management intensity protocols could be a sustainable driver to promote cropland to grassland conversion decisions on marginal land. Therefore, promoting the adoption of management

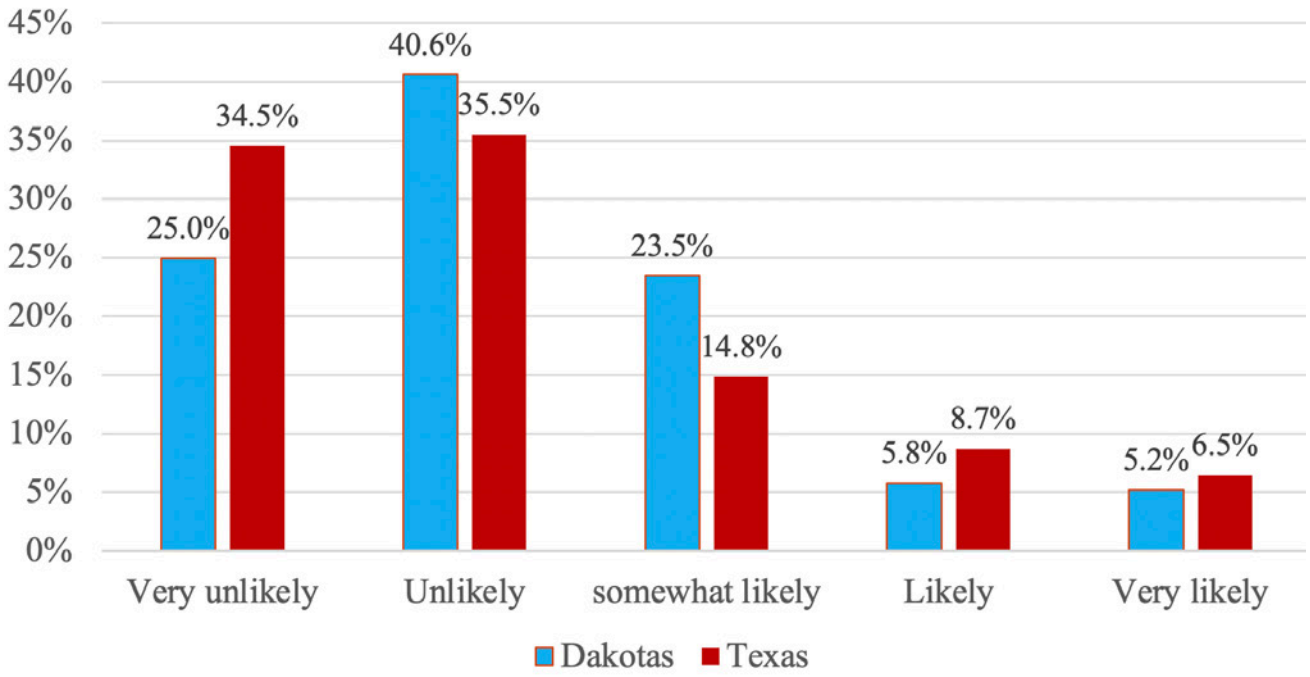

Figure 1: Likelihood of converting cropland to grassland in the next 10 years, by percentage of respondents.

intensive grazing will help improve ecosystem function and environmental benefits in the Great Plains by increasing the amount of well-maintained grassland acres on marginal land.

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7. LANDOWNER PERSPECTIVES

METRICS & PROBLEM SOLVING

Pete Kronberg, North Dakota Grazing Lands Coalition

This talk will show how the metrics and problem solving methods producers and researchers use influence the solutions they find to problems in grass based systems. Metrics such as efficiency, production and consumption are used to shape perception about grasslands. These perceptions in turn affect how producers approach management decisions and how conservationists approach conservation programs. The presentation will explore and explain a few examples of how metrics and methods can either improve or worsen problems in grassland systems.

My passion for this topic came from my design professor in college. He started a group called ICE, Innovation, Creativity and Entrepreneurism. In this group he would lay out a problem and we would dissect it and kick around potential solutions. Now we always ended up with two types of solutions, a high tech solution and a low tech or no tech solution. The high tech solution was almost always relatively expensive and only served to mitigate the problem at best, while the potential negative consequences could be quite large. The low tech solution on the other hand would almost always be cheap and had little in the way of negative consequences. As I thought about this I looked around the world I saw a lot high tech solutions and not many problems being solved. But those high tech solutions were easy to market. I became pretty disenchanted with the field at that point, and that is how a person ends up at a grasslands conference talking about metrics and problem solving.

Let's start off with a problem. There are 2 points on a piece of paper and you have a marker. What is the most efficient way to connect the 2 points? The answer is it depends. First off, in my experience there is almost zero chance that the marker will actually work, so you would have to spend 10 minutes digging in desks to find one that works. But we also have to ask a bunch of questions here. Are we trying to minimize ink usage? Graphite usage? We could fold the paper and smash the points together. Are we worried about energy usage? What form of energy usage? If you are worried about ink usage you might use a ruler to make a perfectly straight line between the two points and that would be an efficient solution. An effective solution would be to ignore the problem entirely because it has very little to do with grasslands.

The reason I started with this example is because how we answer these questions and what metrics we decide to focus on will determine the type of solutions we come up with. Here is a good example of how this can go wrong. A few years ago there was a famous study in California that looked at gallons of water used per calorie of food. Now viewing California's water issues as a water efficiency problem is like looking at a drunk at the end of the bar and saying, "That man has an alcohol efficiency problem." No he has a consumption problem and so does California. Curbing consumption and improving efficiency are two very different things. The metric grassland conservationists need to be focusing on the most is effectiveness. Does it solve the problem at hand well?

Ex 1

Now I'm going to switch gears and show a technique I like to use. Let's look at a technical problem that our operation has and look at possible solutions to it. Coccidiosis.

For the high tech side we have coccidiostats and that is pretty much it. For low tech and no tech potential solutions we came up with changing the waterer to make the water cleaner. Not a bad idea, it should decrease possible contamination and as a side effect cleaner

water should mean heavier lambs. We can also make a conscious decision to account for better nutrition as we graze with the idea that healthier sheep means a more robust immune system. Again a side effect of heavier lambs should be seen, as well as more content and easier to handle sheep. We could also try changing the mineral system so the sheep can balance themselves more effectively. Side effects should also be the same as accounting for nutrition. Removing the Typhoid Mary's from the main flocks should decrease the exposure that most of the sheep will experience. It also makes culling and treatment easier to manage. Lastly selection could be applied to eliminate animals that could potentially have a problem. This may very well get rid of other problems: poor doers, low weaning weights, etc. Let's ignore the coccidiostat, that's an option of last resort, not a long term solution. So we now face this dilemma, what is the best solution to try first? We went with all of them simultaneously and the reason why lies in the solutions themselves. All of them were cheap or free to implement and we could justify the change for other reasons. Now if the problem shows back up we immediately know that the all the solutions were ineffective. If coccidia doesn't rear its head again we know that one solution or a combination of solutions worked. We don't have to know why or how it worked because it was cheap and we can justify them for more than one reason.

This is what I call a David and Goliath problem. When you go up against a giant, formidable, and hard to understand problem, don't show up with just a rock and a sling. Bring a gun, a knife, a plan, and preferably an air strike. In other words attack the problem in every way you can. When I take on a problem my goal is to make sure that problem never so much as twitches again. That way I don't have to spend time and energy dealing with it anymore.

Now let's look at another part of this example. When I talk about having multiple justifications for an action, I'm talking about solving multiple problems with a single action. That is how a solution can become extremely effective.

Let's go now to a set of criteria that will be useful in judging the effectiveness of grassland conservation and regeneration solutions.

Economic
- **Does it increase profit?**
- **Does it decrease costs?**

Financial
- **Is it cheap to implement?**
- **Will it be self funding?**

Ecological
- Does it positively affect multiple conservation issues?

Human
- **Is it easy to implement?**
- Will it make someone happier and healthier?

Social
- Will it be good for PR?
- Will it have a large benefit to the public?

The criteria in bold tend to be where most conservation efforts fall short.

Ex 2

So let's get to how land gets converted from grass. In this scenario let's assume a piece of land comes up for sale and a conventional rancher is looking at the economics. If he buys this piece of land the rancher is looking at a yearly per acre cost of about $200. Running 4 acres/cow for six months on an average year will give him a cost of $800 for six months of grazing. That rancher also has another 6 months of feed to provide for those animal which will cost about $350. On top of that there are vet, machinery, living and other expenses. Keep in mind a 500 lb calf is worth about $900 right now. There are only a few potential outcomes in this scenario. The rancher can buy this if there is old capital with which to buy it. Or the rancher can do something to change the economics, like better grass management. The most likely outcome however is that a corn farmer will buy this piece of land because they are the recipients of some enormous subsidies which get bid into the price of land. This is a real example the only part that is not quite accurate is the yearly per acre payment. In an open auction that number would be $180-$250 per acre per year and will tend towards the high end. Also regardless of who buys

it, this land is one spike in the corn price away from being a corn field. This problem is the economic reality that we have to change if we are going save grasslands. This is the problem that every person at this conference should be trying to solve.

Lastly I want to make a few points on problem solving and conservation to keep in mind. We tend to spend too much time and energy talking about the problem, instead of talking about solutions and experimenting with solutions. As my brother told me once, "Pete shut up and do it already." It works. Don't get to attached to ideas and we need to be ready to throw that baby out with the bathwater at any time. We also have a tendency to make too many defensive moves when we are always worried about *protecting this area and saving this species.* Let's think more offensively. The corn and soybean industry plays a lot of offense and that can be seen in the amount of grassland that has been converted. Moreover that market caps and yearly revenues of major agriculture companies is far larger than the sum of money dedicated to conservation. If we continue to make this a fight of funding we will continue to lose the grasslands. Lastly, get weird. Every solution should be given its day in court.

PROFILES OF REGENERATIVE RANCHING SUCCESS

Kevin Watt, TomKat Ranch

Regenerative rangeland management offers multiple economic, environmental, and social benefits to producers, consumers, and the planet. While these benefits are often measurable and considerable, they are difficult or costly to quantify on such vast and heterogeneous landscapes and therefore often go unrecognized and unappreciated. Life cycle analyses such as TomKat Ranch's Total Impact Measurement and Management Study and White Oak Pasture's Carbon Footprint Evaluation are excellent resources to show the potential of regenerative ranching, however there remains a crucial need to show how average rangeland managers have achieved and benefited from these practices.

In 2018 TomKat Ranch in Pescadero, California began to gather and share the stories of public and private land managers from across the American West who have seen quantifiable benefits from regenerative rangeland management. This work highlights the incredible diversity of practices, practitioners, and outcomes associated with management that focuses on improving both the resilience and productivity of rangelands. These stories have been collected and published in a series called Profiles in Land and Management that can be found at www.landandmanagement.com.

In 2019, the findings from three profiles were presented at America's Grasslands Conference in Bismarck, North Dakota. These profiles explore how public and private land managers from Montana to Chihuahua, Mexico have been able to achieve valuable and lasting social, economic, and environmental benefits from regenerative rangeland management.

NATIVE GRASSLANDS, LIVESTOCK PRODUCERS AS ECOLOGISTS

Karl Ebel, Grasslands Manager and Producer, Sulphur Bluff, Texas

America's Grasslands Conference: Livestock Producer as the Ecologist. Presenter: Karl Ebel, Grasslands Manager/ Producer, Sulphur Bluff, Texas

Introduction

Livestock production on grasslands is often seen as the problem for grasslands ecology. We will look at some techniques and management methods that enable livestock production to be a solution to grassland ecology.

History and Ranch Description

In 2003 a grassland restoration project was initiated on 645 ac in NE Texas. In 2012, 360 additional acres were added to the restoration project. All of the 1057 total acres was "go-back" farm land, farmed and grazed starting about 1834. Through local photographs, testimonials and site assessment by a prairie botanist,

at least 780 acres was originally tall grass Silveus dropseed prairie. In the 1960s after the land would no longer support row crops, cattle were grazed on a set stocked/continuous graze. It was severely overgrazed and overtaken by woody species, broadleaf weeds and lower successional grass species. Today about 70% of grassland acres are native, 30% are introduced species.

In 2005, after the broad-based planting was mostly complete, a stocking of 12 cows and a bull and 600 goats was initiated. Cattle numbers were increased on an average of about 9 cows per year. As brush and large weed infestations were pushed back, goat numbers were decreased. Today the goat herd is maintained at about 45 mother goats (about 75 kids goats are sold each November). The cow herd is at about 130 mother cows. Adjusted by weight to AU (animal units) the stocking rate is now about 1 AU / 6 acres, grazed in rotational grazing management.

Rotational Grazing

This is probably the single best management tool we use for both the economics and grassland ecology. This graze - rest / recovery method of grazing mimics what the migrating buffalo herds did for the grassland ecology. There are a variations in rotational grazing management such as; intensive or mob grazing, adaptive multi paddock grazing. All of these variations managed properly are far superior to the traditional set-stock approach for grassland ecology and production / management economics.

Pasture rotations are based on:

- minimum gazing height of species being managed/ grazed
- adequate recovery period for forage species
- nutritional requirements of cattle
- stockpile forage requirements
- logistical constraints for moving livestock

Prescribed Burning

Prescribed burning was initiated in 2004 and is carried out on various acreages in February of each year. Some pastures are burned every year, some are burned every 3-4 years, depending on the dominant grass species and the desired woody species control.

Restored to a More Productive Land

Grass is viewed as the resource and livestock simply offer a means to turn this resource into profit. One of our primary goals is continual improvement in the grassland. The first 645 acres was divided into pastures of various sizes. Restoration began with a textbook approach - native grass broad based planting. Some areas were recognized as possibly never having been plowed and were not plowed and planted in this broad based planting. Proper grazing management, brush removal/ control facilitated restoration of these areas. At the start of restoration, a proper assessment is very important. Identifying which species and their present state, and possible areas that were never plowed will greatly facilitate a restoration plan. Help with species identification and grassland condition is readily available from local botanist and grazing specialist/organizations.

Another 360 acres were added to the ranch in 2012. No broad based plantings have been done on these acres. Rotational grazing and prescribed burning have been carried out along with a trampling method of planting.

No Hay

In 2009, it was decided that the native grass pastures had progressed enough to take the hay supplementation out of the wintering plan. Hay supplementation is substituted with stockpiled forage. A 38% protein cotton seed cube is fed as protein supplement. About 40 bales of hay are kept under covered storage, and over the last 8 years, hay has been fed to the cattle for 3 two-day periods, during extreme snow and ice conditions. The elimination of hay from the wintering program has been a huge benefit to our economics.

Planting by Trampling

The initial broad based native grass plantings were somewhat successful, with about half of the planted acreage having somewhat established plant populations. In 2009, after observing how the cattle were disturbing the ground as they fed on the supplement cubes, a method of trample planting native grass was developed and continues with good success.

Economics

In order to achieve sustainable economics, some basic beef production goals/assumptions
should be made.

- Adjust stocking rates/grazing plan as needed to protect the grazing resource.
- All forages require rest periods. Introduced species can, in general, stand periods of higher grazing pressure.
- Longer rest during seed producing periods will greatly enhance native plant restoration.
- A cow's "Body Condition Score" at calving must be a 5 or higher.
- A "weaned calf crop" of 90% is an attainable and economical goal.
- A variety of forages will greatly aid in management options and the success of the economics.

Annual cost to keep a cow at Ebel Ranch
2014: $325.00
2017: $315.00
National US average to keep a beef cow: 2016: $875.00*
*Source: Livestock Marketing Information Center
List of expenses in annual cost calculation
(2014/2017):
Expenses 2014 2017
- Chemicals/Herbicide - 4,400 2,442
- Vet/Vet Supplies - 2,362 3,295
- Bulls - 1,750 1,750
- Fuel/oils - 1,247 1,189
- Mileage, farm (.45/mi) - 2,142 3,274
- Feed/hay, (cattle) - 7,200 6,280
- Feed/hay (goats) - 1,540 1,520
- Mineral (cattle & goats) - 1,908 3,034
- Seed (native) - 600 269
- Fertilizer - 1,440 1,750
- Water (troughs) - 750 663
- Parts/Repairs - 1,660 1,321
- Fence Maint - 500 683
- Pasture rent - 583 583
- Labor - 250 353
- Property Taxes - 3,400 3,442
- Insurance - 450 450
- Equipment Cost, amortized - 3,000 3,000

Total $35,132 $35,513

Finance Plan for Restoration/Management

Ecologically and economically sustainable livestock production offer a means to sustain our native grasslands. Ecologist and livestock producers have a history of conflicting goals but his need not be. Grassland ecology and livestock production fit together extremely well, when managed to mimic the grazing ecology of the migrating buffalo. As we step out of our comfort zone and begin to learn from the "other side" we build relationships across boundaries. It may seem that, "those practices / challenges are of no concern to me or my area of specialty" but understanding the challenges that all those in the collaboration face is paramount to building the relationships across boundaries. Something as simple as volunteering or offering services at a working ranch, or inviting grassland ecologists to experience livestock management at livestock producers field days can initiate this much needed collaboration.

Summary

The results of this collaborative effort between livestock producers and grassland ecologists can provide both the ecological and economical results
that the American grasslands need to thrive through future generations.

RANCHING FOR THE FUTURE

Chad Njos, Cow Chip Ranch and North Dakota Grazing Lands Coalition

My wife, Amanda, and our four children, Tobias, Zakai, Molly, and Elliot, operate a cow/calf operation in southwest North Dakota. We have adopted Holistic Management principals to improve our resources and quality of life. Through high intense grazing management and a focus on improving soil health, we have increased soil health, animal health, and human health.

Before making changes on our operation, Amanda and I took a number of steps to help us be successful in making these changes.

1. Defined the goals of our operation – Production, future resource base, and quality of life.
2. Educated ourselves on the effects of these changes.
3. Surrounded ourselves with a supporting network of knowledgeable individuals.
4. Developed partnerships with entities that valued natural resources.
5. Added infrastructure and implemented practices.

I believe these are all very important steps to successfully implement management changes on an operation. I have had many people ask me, "If this has been so successful for you, and others, why don't more producers adapt these concepts?"

As a mentor for the North Dakota Grazing Coalition, I have spent hours contemplating this question. How do we help producers take the next step to improve both their resources and their quality of life? These are my thoughts.

To have a successful business, long term planning is essential. Developing a set of long term goal helps, not only in our long term planning, but, also, in our day to day decision making. Without this roadmap, we can be influenced by ideas that will have long term effects.

If we can help producers define their goals, then they will be able to find the value in making changes to their operation that will be positive and long lasting. It is very important for producers to understand the value of their management. We can improve many resources through good management: water quality, soil health, healthy food, air quality, pollution, wildlife, etc. Without a long term understanding of the value of proper management, people have a tendency to return to their previous management or not make any changes at all.

Most income on a farm or ranch comes from the commodities they produce. We need to find value in all the resources available. Producers need to build partnerships with groups that will help them find value in the resources and help promote these actions. This will also reduce the heavy burden of risk which is placed on farmers and ranchers by businesses that receive financial gain. These companies in turn, do not accept the accountability for the long term effects of their products. By forming these partnerships, and relying on a knowledgeable support system rather than a product based support system, everyone can have a help each other create a more successful future.

I feel our financial institutions are also failing the agricultural industry. The focus is on production over profitability. There is more profitability in regenerating resource rather than adding more degraded resources. Neighbors should be working together, rather than competing.

A lot of research is available in the agriculture field, but many times, this information is a one size fits all, or not user friendly to producers. I feel more research needs to be done in conjunction with individual producers in real life settings. This information can then be used to help the producer improve his management to his ability or comfort level.

One of the biggest concerns I have is the lack of youth in agriculture. The average age of producers in the ag industry is just under 60 years of age. Young people provide ambition and creativity. The experienced producers can provide knowledge, support, and opportunity. If we can find was to link generations together, agriculture will have a bright future.

These are just few simple insights from a rancher that has a passion for God's creations and the future generations in agriculture. Together, we can make a difference.

8. WORKING LANDS AND GRASSLAND CONSERVATION

STEWARDS OF SASKATCHEWAN: A LOOK AT OVER 30 YEARS OF HABITAT CONSERVATION FOR GRASSLAND SPECIES AT RISK

Jordan Ignatiuk, Nature Saskatchewan

Other Authors: Rebecca Magnus, Emily Putz, Ashley Vass, and Melissa Ranalli, Nature Saskatchewan

Founded in 1949, Nature Saskatchewan (NS) initially sought to promote the conservation of our natural resources by asking its members to lobby governments and their agencies. NS also promoted our provincial publication the *Blue Jay.* Over the years, NS has expanded its activities, encouraging the public to be involved in different ways. Youth are encouraged to build a relationship with nature through the Nature Quest and NatureHood programs. These programs reach out to school groups through games, music, and story-telling, encouraging students to consider how their lives connect to nature. NS brings like-minded people together to enjoy and explore the natural history of Saskatchewan through meets, gatherings, and by encouraging people to join or participate in one of 15 local societies or affiliate groups around the province.

Supporting citizen science, research, and education is also a priority for NS. Through NS, many special publications have been produced including the *Birds of Saskatchewan* and many field guides specific to the province. NS contributes to the knowledge base of species data through the Last Mountain Bird Observatory and Important Bird and Biodiversity Areas. Further, the Stewards of Saskatchewan programs mix many of NS's approaches, such as face-to-face education and citizen science, to engage landowners and managers in habitat conservation through voluntary stewardship.

Recent Plowprint Reports show that native prairie and perennial grassland is still being converted to cropland at an alarming rate (World Wildlife Fund 2017). A recent study highlighted that approximately 13.7-15% of grassland is left in Saskatchewan (Doke Sawatzky 2018). Active stewardship by landowners is integral to the conservation of this remaining prairie landscape, since approximately 85% of southern Saskatchewan's grasslands (native and tame) are privately managed (Saskatchewan Watershed Authority 2002); and approximately 40% of the remaining native grasslands are under private ownership (Michalsky and Saunders 2009). Nature Saskatchewan's Stewards of Saskatchewan programs have been working with landowners and land managers in voluntary stewardship since 1987 to conserve or enhance remaining habitat for target species at risk, also benefitting the species that share their habitats across southern Saskatchewan.

The Stewards of Saskatchewan is a suite of five programs: Operation Burrowing Owl, Rare Plant Rescue, Shrubs for Shrike, Plovers on Shore, and a banner program that includes all other species at risk. Operation Burrowing Owl was the first stewardship program, and is one of the oldest and longest running stewardship programs in Canada. The target species serve as conservation ambassadors for their habitats, ultimately benefiting many other species that rely on having that same habitat intact.

To engage the public and landowners, program staff highlight the benefits of having the ambassador species on their land and why the species matters. For example, Burrowing Owls and Loggerhead Shrikes are both great forms of natural pest control, and having these species on their land is also an indication of the habitat's value and reinforces that landowners are doing an excellent job caring for it.

Species at risk locations and resulting potential program participants are identified through searches and incidental species at risk sightings from NS staff, current participants, the public, and partner organizations. Potential participants are then contacted and visited by staff to initiate a working relationship, go over relevant species, habitat information, and beneficial management practices, and introduce the Stewards of Saskatchewan programs.

By agreeing to participate in the Stewards of Saskatchewan programs, landowners and land managers commit through a voluntary stewardship agreement to not destroy the species at risk habitat on their land, and to participate in our annual census, or let program staff monitor occurrences. For plant species at risk targeted by Rare Plant Rescue, NS staff work with participants to search and monitor sites for specific plant species following established survey guidelines (Henderson 2009). For non-plant target species, participants help keep track of populations through an annual census. Participants are asked to report land use changes, whether or not they observe nests, juveniles or other species at risk. This is a great way to keep participants engaged, but it also amounts to a large amount of species at risk monitoring data that would not otherwise be possible to collect by program staff alone. In return, participating stewards are provided with benefits and recognition for their stewardship.

With participants' permission, data collected are shared with the Saskatchewan Conservation Data Center and Environment and Climate Change Canada recovery team chairs. These data can be included in recovery strategies, and ultimately contribute to species statuses, listings, and known ranges. Data collected through the Rare Plant Rescue program has contributed to the down-listing of several plant species at risk, such as Hairy Prairie-clover and Buffalograss, and has expanded the range of Slender Mouse-ear-cress approximately 90 km southeast of its previous range (Lee, personal communication).

Currently, the programs have over 860 participants conserving nearly 130 miles (209 kilometers) of shoreline and 340,000 acres (137,600 hectares) of habitat, including critical habitat for multiple species at risk. Most landowners and managers are willing to participate in a voluntary stewardship program, especially one which provides information and guidance about rare plants and wildlife. Another reason the Stewards of Saskatchewan programs are embraced by landowners is that voluntary actions involve a lower amount of risk to producers. The Stewards of Saskatchewan voluntary stewardship agreements are not legally binding and do not influence land value, however, they have been shown to be effective conservation measures.

A study conducted in southern Saskatchewan showed that two thirds of land under an Operation Burrowing Owl voluntary stewardship agreement was conserved (between 1987 to 1993), compared to approximately half with no agreement over the same time period (Warnock and Skeel 2004). Not only are these agreements effective at a voluntary level, but they can lead to legal forms of protection in the future, such as conservation easements, which are promoted through printed materials and discussions during on-site visits.

It is understood that some of the beneficial management practices suggested may come with a cost. To encourage implementation, and as a benefit of participating in the programs, funding is provided on a 50:50 cost share basis with participants for certain projects that can increase or improve habitat for species at risk (i.e., Burrowing Owls, Sprague's Pipits or Piping Plovers). These projects are a win-win situation for both landowners and wildlife. Since initiation in 2000, Nature Saskatchewan has funded 135 projects resulting in over 15,000 acres (6,070 hectares) of land seeded back to grassland, 64 miles (103 kilometers) of strategic fence installed, and 17 alternate watering sites established. Enhanced sites are monitored, including for use by Burrowing Owls. On average, each year 3 to 5 Burrowing Owl pairs, or 10-20% of all owls reported, have been seen nesting on these enhanced sites.

The Stewards of Saskatchewan programs partner with many organizations to provide participants with as many resources as possible including Nature Conservancy of Canada, Ducks Unlimited Canada, Saskatchewan Wildlife Federation, Saskatchewan Burrowing Owl Interpretive

Centre, Saskatchewan Prairie Conservation Action Plan, Native Plant Society of Saskatchewan, South of the Divide Conservation Action Program Inc., local watershed groups, a number of universities, and various levels of government. The target species do not exist in isolation in Canada, so networking and sharing of information also happens with international partners such as Coastal Bend Bays and Estuaries in Texas, Pronatura Veracruz in Mexico, and American Prairie Reserve in Montana.

Success does not come without its challenges. Political agendas change, affecting government funding availability, which makes up more than half of the cash contributions to these programs. Funding priorities and the types of information required for applying and reporting are often changing as well. This can require a considerable amount of administrative time and effort to keep up and adapt. Public perception of conservation has been a challenge in the past as well; although landowners and their families are generally open to the topic of conservation and having discussions about it now. With Operation Burrowing Owl being 32 years old, it comes with the challenge of ageing participants and lands changing hands, as well as landlines being disconnected in favour of cell phones.

A big part of the programs' success is a direct result of the participant relationships built over the decades. Through face-to-face conversations, the learning (for both participants and staff) and sharing of information and resources is ongoing. And these efforts are worth it for all parties involved. Participants have shared testimonials over the years, and they often portray a similar view. Participants are proud to set an example and conserve habitat for biodiversity and the next generation to enjoy. They often feel that by engaging with these programs valuable species at risk monitoring and extension events, as well as habitat enhancement projects can take place. The Stewards of Saskatchewan team reciprocates this notion and is grateful for the opportunity to work with our committed participants.

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BUILDING CONNECTIONS WITH WORKING LANDS AT THE COUNTY LEVEL

Daniel Casey, Northern Great Plains Joint Venture

The Northern Great Plains Joint Venture partnership is identifying win-win solutions for producers which will help reduce or reverse grassland bird species declines. Our Conservation Guidance Directory combines measures of land use, soil, habitats and bird species models for each of the 68 counties in the joint venture. It sets spatial priorities and opportunity sideboards for habitat restoration, enhancement and protection in a local and regional context. Partners are using this decision support tool to inform the delivery of voluntary and incentive-based (e.g. Farm Bill) programs and practices on working rangelands, in a landscape where the future of grassland birds and local communities depends on the success of agricultural producers.

A WORKING GRASSLANDS APPROACH TO PUBLIC AND PRIVATE LAND MANAGEMENT

Kevin Kading, North Dakota Game and Fish Department

Other Authors: Curtis Francis, and William Haase, North Dakota Game and Fish Department.

Introduction

The North Dakota Game and Fish Department's (Department) mission is to protect, conserve and enhance fish and wildlife populations and their habitat for sustained consumptive and nonconsumptive use. From the onset of its assigned responsibility to manage and conserve the states wildlife resources, the Department understood the importance of habitat enhancement on the land as a means of fulfilling its mission. Effective fish and wildlife management could only be accomplished through proper management of fish and wildlife habitat. The Department identified two possible strategies for protecting, conserving, and enhancing fish and wildlife habitat as well as the challenges associated with these strategies.

One strategy was to acquire portions of the North Dakota land base by the State for the specific use of fulfilling that mission. Though these publicly owned lands could be developed and managed with wildlife production and public use as the direct objectives, financial and political constraints limited these acres to a very small percentage of the North Dakota land base. These limited acres could not be expected to influence wildlife populations statewide. The other strategy was to stimulate proper conservation and stewardship on privately owned land. Conservation education and assistance through various programs was needed to make impacts at a statewide level. Examples of these strategies can be found on lands the Department owns and manages, and on private land agreements the Department holds with landowners.

Managing Wildlife Management Areas

The Department owns and manages approximately 200,000 acres. These Wildlife Management Areas (WMAs) are managed for wildlife production and public use. Throughout much of its history, the Department has viewed grazing as incompatible with wildlife habitat management. Many WMAs had little to no grazing since the Department acquired them. Over time, biologists have noticed a shift from desirable native plant species to unwanted, introduced cool season species and a decline in overall plant health and diversity. Over the past two decades, the Department has shifted its views of grazing. Working with grassland experts, grazing specialists and ranching groups, the Department is incorporating planned grazing on many of its WMAs. This shift has required installation of infrastructure such as fence, water, and power (Figure 1).

Working in cooperation with ranchers, properly planned grazing has resulted in increased diversity of desirable plants which is beneficial to many species of wildlife. While every WMA is different, one common approach is to utilize high intensity/short term grazing in the

Figure 1. Infrastructure, such as fencing, water and power has been developed on North Dakota Game and Fish Department Wildlife Management Areas.

spring, once every two to three years. Livestock must be removed early enough to allow adequate regrowth for fall hunting cover. Early grazing appears to help with Kentucky Bluegrass and Smooth Brome expansion and biologists have observed increased composition of native species and improved stand vigor. The Department is currently participating in Northern Prairie Adaptive Management (NPAM) on four WMAs. NPAM was developed by the US Fish and Wildlife Service to help land managers improve the vegetative composition while reducing Kentucky Bluegrass and Smooth Brome. As part of NPAM, some management prescriptions may include rest, graze, burn or burn/graze. The Department has experienced some challenges with NPAM, however. With limited manpower and personnel, the Department's ability to monitor the areas can be difficult. Furthermore, NPAM requires an annual vegetation survey and some of the management prescriptions can pose a challenge due to lack of trained staff and limited timeframes for management such as prescribed burns. Additionally, the Department must keep in mind that WMAs are managed for hunting and wildlife production. Some management prescriptions leave minimal vegetation for wildlife and hunting.

Managing Private Lands

The Private Land Initiative (PLI) is the Department's primary mechanism for applying its mission on to the private landscape in North Dakota. Private Land Open To Sportsmen (PLOTS) is a component of the PLI which develops habitat and public access for walk-in hunting through agreements with private landowners. One facet of PLOTS is the Working Lands program. Through this program, the Department works with private landowners to maintain or enhance beneficial conservation activities and management practices on working farms and ranches. Management plans are designed to fit into the landowner's agricultural operation while meeting Department's habitat objectives as well. The key to this successful program is its flexibility and wide menu of options. Plans may be tailored to individual situations and include features such as development of riparian pastures, planned grazing, infrastructure cost share and other practices that benefit fish and wildlife habitat.

The PLI is funded by hunters; license sales and interest accrued from the Department's general fund, make up the bulk of its funding source. Because of unique funding source, the goal is to manage these private lands for hunting access and wildlife production. Similar to public lands, which are also funded by hunters, there is a need to balance "allowed use" with habitat for hunting. Expectations by hunters is that there will be adequate wildlife habitat and hunting cover on PLOTS land (Figure 2). However, not all years are created equal, and not all landowners are created equal, so habitat and quality can vary based on these factors.

Figure 2. Hunters expect adequate wildlife habitat and hunting cover on PLOTS land.

The Department faces additional challenges on private lands, such as absentee ownership or landowners not involved in farming or ranching, landowners not having the same desired outcomes as the Department, disagreements between landowners and tenants and many other reasons.

Conclusion

Managing public and private lands to maximize wildlife production and healthy plant communities in conjunction with planned grazing can be challenging but it can also prove to be successful. Working in cooperation with ranchers on public and private lands has increased the Department's ability to influence management of our WMAs and on private lands. Thus, the objective for the Department is incorporate a working grassland approach to maintain diverse, high quality habitat by continually adapting management techniques on owned and managed lands, while maintaining a proper balance of adequate wildlife habitat and hunting cover for hunters.

CANDIDATE CONSERVATION AGREEMENTS WITH ASSURANCES AS A TOOL TO ADDRESS THREATS ON PRIVATE LANDS IN MONTANA

Kelsey Molloy, The Nature Conservancy

The Nature Conservancy (TNC) in Montana is using a Candidate Conservation Agreement with Assurances (CCAA) as a tool to engage private landowners in proactive conservation for greater sage-grouse and four declining grassland songbirds (Sprague's pipit, McCown's longspur, chestnut-collared longspur, and Baird's sparrow). A Candidate Conservation Agreement with Assurances (CCAA) is an agreement between US Fish and Wildlife Service (USFWS) and a non-federal landowner, designed to address threats to species in advance of an Endangered Species listing and potentially

avoid an Endangered Species Act listing. TNC develops site-specific management plans with landowners that address twelve threats to these bird species. Threats include habitat loss and fragmentation, conifer encroachment, infrastructure and non-native plants. TNC, with the assistance of USFWS, helps landowners implement projects such as grassland restorations, improved grazing systems, and fence markers to address threats. In return landowners receive regulatory assurances in the event of an Endangered Species Act listing. 94,000 private acres on 8 properties are currently enrolled in eastern Montana. As part of the habitat monitoring TNC has worked with a contractor to design a vegetation monitoring program using drone imagery, which is just getting underway.

HOW JOINT VENTURES WORK WITH LANDOWNERS THROUGH THE GRASSLAND RESTORATION INCENTIVE PROGRAM (GRIP)

Steve DeMaso, U.S. Fish and Wildlife Service and Aimee Roberson, American Bird Conservancy

The Grassland Restoration Incentive Program (GRIP) was developed and implemented in 2013 by the Oaks and Prairies Joint Venture. GRIP is a voluntary program that reimburses private landowners a set payment rate for identified practices that address the greatest limiting factor(s) to provide suitable grassland bird habitat on their property. Practices generally fall into the categories of brush management, prescribed burning, native grass reseeding, and prescribed grazing. A small portion of this original GRIP delivery area extended into the Gulf Coast Joint Venture (GCJV) geography and was supported by the GCJV partnership. Building on the success of the original GRIP, the Rio Grande Joint Venture began South Texas GRIP in 2017, and the GCJV began more comprehensively implementing Coastal GRIP (C-GRIP) in 2018.

The three Migratory Bird Joint Ventures (JVs) now implement GRIP within their own geographies and with the support and guidance of their multi-organizational and geographic-based management boards. The three JVs work collaboratively to maintain unity in the GRIP concept – voluntary, incentive-based, professionally-guided, bird-focused grassland conservation on private lands – and in program implementation details (e.g., eligibility requirements, practices, and payment rates). Each JV maintains responsibility for funding and implementation of each slightly unique version of GRIP. Using the GCJV's C-GRIP as an example, the eligibility requirements include:

1. Treatment area is at least partially located in a focal area.
2. Treatment area is on private land.
3. Treatment area is at least 25 acres in size.
4. Treatment(s) being proposed are on the eligible practice list and in accordance with C-GRIP Project Manager recommendations.
5. Landowner agrees to contribute to the project an amount equal to the amount they will receive in C-GRIP funding.
6. Maximum amount for individual projects is $50,000.
7. Long Term Potential - must meet at least one to qualify:

- Landowner is committed to maintaining improved state of habitat in project area for at least 5 years after project completion.
- Property is under a natural resource conservation easement.

From September 1, 2018 to August 16, 2019 C-GRIP has received 17 projects for funding and funded 13 of those projects. So far, the total acres enrolled in C-GRIP is 11,665 acres, resulting in a cost of about $35.00 per acre. The most utilized funded management practices include brush management, fire breaks, and disking.

In comparing the experience of the three JVs in implementing GRIP over the past six years, several lessons learned are evident, and it has been helpful to reflect on these as we work on expanding the scope and scale of the program and transferring it to new geographic areas:

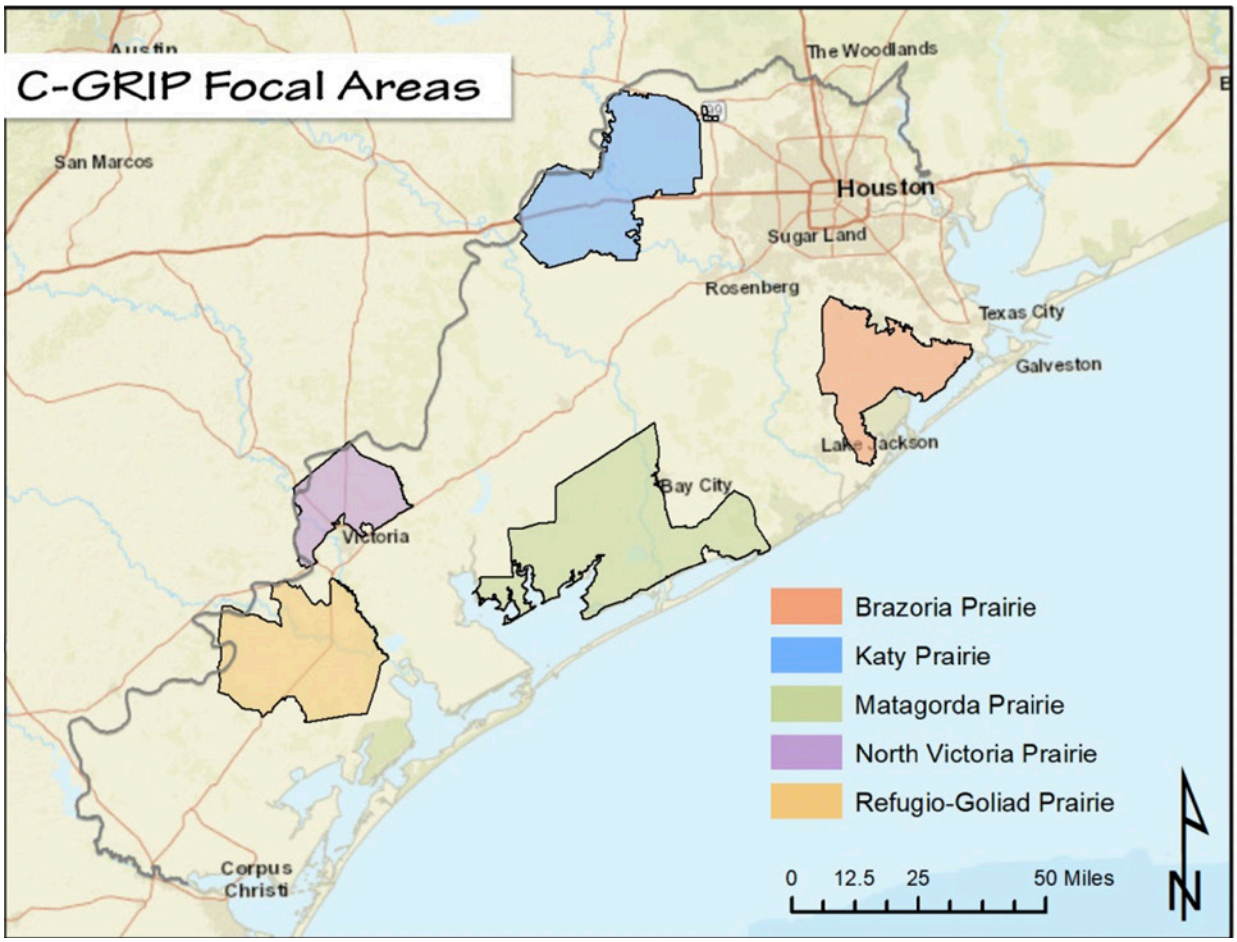

Figure 1. Gulf Coast Joint Venture C-GRIP focal areas for the central Texas coast.

1. Building a partnership-led program takes time and patience because strong partnerships are built on a foundation of strong relationships and trust.

2. A successful partnership amplifies what is already working and fills in the gaps needed to expand successful programs.

3. Creating clear and concise project evaluation criteria based on specific habitat goals and objectives ensures that partners have a good understanding of what kinds of projects to develop and makes the project approval process more efficient.

4. The success of the program will be dependent on the ability of partners to adapt and incorporate new information as the program is implemented and grows. This must be consciously cultivated through an adaptive management framework in which the learning process is explicitly built into the decision-making process.

5. Ultimately, due to the large scale of grassland habitat loss and degradation, programs will eventually need to be scaled up to adequately address the issues and positively impact declining bird populations. This growth and how to implement it should be anticipated and planned for in advance.

GRIP has been implement across three JVs based in Texas and surrounding states and is now starting to be adopted by other JVs across the network (e.g., Norther Great Plains JV). The GRIP model has proven to be a successful and transferable way to scale up public-private programs wanting to improve grassland habitats for birds and other wildlife.

9. GRASSLAND CONSERVATION PARTNERSHIPS

CONSERVATION BY COMMITTEE

Leo Barthelmess, rancher and Rancher Stewardship Alliance

Other authors: Marisa Sather (USFWS), Kelsey Molloy (TNC), Martin Townsend (SGI/NRCS) and Brett Dorak (Montana Fish, Wildlife and Parks)

The Ranchers Stewardship Alliance was founded in 2001 by local ranching families in northcentral Montana. Our mission is "Ranching, Conservation, Communities, a winning team!" and we are deeply committed to this triple bottom line. Since 2017, RSA has hosted a "conservation committee" with active membership from more than 10 conservation groups, including federal and state agencies as well as nonprofits. Guided by the community, this committee has administered over $500,000 in grant funding in the past two years to conservation projects on the ground in a collaborative fashion. To date, our efforts have affected 18,000 acres of private grasslands and 16 different ranching families.

PARTNERS IN CONSERVATION OF THE CHIHUAHUAN DESERT GRASSLANDS

M.C. Nancy Hernández Rodríguez, IMC Vida Silvestre A.C.

Other authors: Roberto Rodríguez Salazar, IMC Vida Silvestre A.C.; Arvind Panjabi, Bird Conservancy of the Rockies; Allison Shaw, Bird Conservancy of the Rockies

IMC Vida Silvestre (IMCVS) is a relatively new organization but with a long history of working in the grasslands of central Chihuahua, Mexico. These grasslands support 32 grassland-dependent bird species that are our main conservation issue. More than 80% of the grassland bird species that breed in western North America spend winters in the Chihuahuan Desert and at the end of the same start the journey to breed in the grasslands of the United States and Canada. This means that Chihuahua's grasslands are part of the so-called "Full-life cycle conservation" (USFS 2014). The problem of grassland birds; is that populations of species such as the Baird sparrow (Ammodramus bairdii), the brown-collar scribe (Calcarius ornatus) and the Sprage Pipit (Anthus spragueii), which has lost about 66% of its population and is susceptible to changes such as overgrazing (Pool et al. 2012). For this the importance to preserve the habitat we all have in common species through our common objective; sustainable cattle grazing. To achieve our goal, we work by a Sustainable Grassland Red with the iniciative and support of Bird Conservancy of the Rockies and for people whom are the guardians of the resources. Our group in conjunction with a national and international partners work in support better cattlemen actions, specific habitat actions and the monitoring using birds as indicators to understand the actions we support and use. Through their management of the land they can positively affect the soil, flora and fauna, and help make the land more resilient to climate change. Our achievements include the stewardship with 500 livestock producers and technicians in 4 forums, 30 workshops and 5 field schools in three Mexican states and 2 countries. Collaboration with 17 agreements with owner for grassland conservation and improvements for sustainable cattle management. Eleven years of monitoring of grassland birds and habitat in 300 sites. We have been improving 2,000 hectares of habitat actions, 157 ramps, 61 water tanks, 12 water storage, 46 km of pipes, 186 km of fences and 64 APFA nests, 139 close pipes, 4 solar system water pumping.

We work also in a local level with high school students giving classes in biodiversity, pollinations gardens, and developing educational material adapted to the

grassland. All this because young people treasure their resources, and their culture, which is also grassland dependent. We believe the key is to be partners in conservation. In the environmental education we have been working with 15 Telesecundarias with environmental education and 10 ecological clubs.

All the work we do we do it thorough collaboration in all levels, in Mexico and other countries. The main objective of our participation in the American´s grassland conference was to present the Mexican work in grassland preservation and the importance for the species we chare and we need to work for.

We thank to all the people who support us, and mainly the owners who support conservation for a true passion of nature and with a true vision for the future generations.

The presentation was presented in the Grazing management and integrated systems approaches

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PLANNED GARDENING: ENHANCING OUR PRAIRIES PUBLIC LANDS THROUGH PARTNERSHIPS

Dane Buysse, Ducks Unlimited

The Grasslands Enhancement Pilot Project brings together experts from various backgrounds to benefit public and private lands in North Dakotas Bakken Region. Coordinating with state and government agencies, private landowners, corporations and non-profit organizations, cattle are being used as a tool to enhance public and private grasslands with assistance from the Outdoor Heritage Fund. This project was developed with ranchers for ranchers to connect conservation lands and private lands. Working with over 250 private landowners in North Dakota from 2014 to 2019 there were many conversations about resource concerns. Conversations during low moisture years revolve around water quality. These conversations are what molded the GEPP.

TRANSBOUNDARY GRASSLANDS PARTNERSHIP: COORDINATING NATIVE GRASSLANDS CONSERVATION IN ALBERTA, MONTANA AND SASKATCHEWAN

Linda Cerney, Alberta Prairie Conservation Forum

Other Authors: Sasha Harriott, Alberta Prairie Conservation Forum, Marisa Sather, Montana Fish and Wildlife Service, Heather Nenninger, Montana SWCDM/NRCS

The Transboundary Grasslands Partnership is a voluntary collaborative partnership. The partnership was initiated in 2015 with a small group of grassland specialists including members of the Alberta Prairie Conservation Forum and the Government of Alberta.

In 2016, the first workshop was held in Elkwater, Alberta bringing agencies from Alberta, Saskatchewan and Montana together. As a direct result of this workshop a group of individuals established a core team to address initial objectives including: to become familiar with the broad scope of work and accomplishments of large landscape; conservation trans-boundary collaboratives; review the status of existing trans-boundary grassland initiatives with focus on successes, challenges and outcomes; discuss existing jurisdictionally-based environmental, land use and natural resource

Transboundary Grasslands Partnership Location. Inner dotted line identifies the current core location.

management priorities and challenges; and identify potential topics where new or enhanced trans-boundary collaboration may result in better outcomes. This has led to the development and formation of the Transboundary Grasslands Partnership. Interest in the concept further led to the establishment of a core team of representatives from each of the three jurisdictions.

Our vision is one of collaboratively sustaining healthy native biodiversity and the supporting grassland ecosystems and communities. Three guiding principles help direct the partnership:

Enhance - the health and function of native grasslands, by building on successes and challenges and awareness amongst the partners,

Create - working towards collaborative actions that address gaps in transboundary native grassland conservation, and

Connect - acknowledging and improving transboundary communications, relationship building, education, cooperation and messaging between partners, Tribes and First Nations and interested organizations and individuals.

The partnership agreed to hold an annual workshop 'connecting' government agencies, producers, researchers, non-government agrencies, First Nations and Tribes, and interested individuals together. Workshops are rotated through the three jurisdictions. Four workshops have been held: Elkwater, Alberta (46); Swift Current, Saskatchewan (65); Glasgow, Montana (40) and Lethbridge, Alberta (83). Participation and interest in the partnership has increased over the years of the delivery of these workshops (see numbers in brackets above).

In addition to connecting, building awareness and improving communications around grassland conservation across transboundary borders, the workshops generate topics and ideas that the core team will utilize in the development of an annual workplan that will help the partnership grow and work together. Items include exploring improved communications and common narrative, information and data sharing, and potential partnering on projects. The partnership will promote enhanced networking and linkages and will respect boundaries of interest and will not duplicate effort.

Alberta agencies currently participate in the partnership by providing the chair position since its inception (2015-2019), secretariat support and logistics and seed funding for the workshops. In addition, Alberta hosts and maintains the partnership webpage populating it with information from the workshops. Montana has taken charge of the social media aspect of the partnership and has created a Facebook page as well as overseeing a partnership action items on potential data sharing opportunities, and actively keeps the Canadian partners aware of emerging U.S. State challenges. Saskatchewan partners contribute to the development of the workshops, sharing information, has assumed the chair responsibilities (Fall 2019) and will host the fifth workshop in 2020.

Additional partnership achievements to date include: continued core team conversations and decisions, increased interest and participation at workshops, delivery of work plan activities (e.g. data survey-led by Montana; interactive mapping project to identify gaps in the partnership and current locations of our partners, social media partner use overview and grassland conservation tools used by partners- led by Alberta;

and next workshop coordination, led by Saskatchewan) and one of the most significant achievements is the amount of increased communicating and networking amongst partners.

Through the 'infancy' stages of this partnership, we have faced some challenges, the earliest was buy-in from jurisdictions and agencies, and resources for addressing the work plan. We have and continue to acknowledge and work towards overcoming challenges and lessons learned along this journey including:

Improving transboundary capacity

• *Identifying Gaps in Partnership* - Are we reaching enough people and the right people? Getting the appropriate investment of capacity and personal commitment;

• *Identifying Potential Collaborative Opportunities* - Being proactive not reactive and learning from each others programs successes and failures. Using our collective interests not just individual interests;

• *Sustaining the Momentum* - Interest continuity and ensuring that all jurisdictions are leading and not just Alberta as being the driver. Engagement and planning participation and leadership by many (than a few);

• *Identifying Funding Options* - Currently we have no dedicated funds towards the partnership, it is all by in-kind and donated (monetary and materials) support. Exploring adequate fiscal resources and from different sources;

• *Future Role of Administration* - Alberta currently offers secretariat support, when do we become our own entity?

• *Monitoring/Evaluation* - As we enter our fifth year and work progresses, are our targets and outcomes being achieved and how are we determining next steps for moving forward? Evaluating and measuring success is needed for justification to our agencies and the partnership;

• *Ability to Travel beyond Boundaries* - Agencies have placed restrictions and costs associated with travel outside their jurisdictions, making it difficult to meet in person for meetings or attending the annual workshops, thus, most of the core team conversations are either by phone or online, limiting the ability to have wholesome, interactive discussions on initiatives. Championing our agencies for continued and increased support in the value of this partnership and addressing collaborative future native grassland actions.

Implementing the Work Plan

• *Getting more partner involvement* - The core team has initiated many of the work plan items, requiring additional support from partners to lead and/or build on new and existing projects. Motivation by participants and contributions is necessary to meet our strategic direction and outcomes.

• *Sharing Information and Data* - Data sharing agreements and access, standardization of collecting data, and availability; are challenges that need to be addressed. Finding innovative and creative ways to share and participate in data collecting without compromising privacy concerns.

• *On the ground work* - Actions are slowly being achieved. We can accomplish more together.

Improved Communications

• *Supporting partner connections* - Information sharing through our Facebook page and partners promoting each others events is a great start. It is also about listening and understanding each others work and needs.

• *Common understanding and messaging* - The greatest achievement that requires time is Respect, Trust and Commitment, and can easily be lost in a matter of minutes.

Across the three jurisdictions we are experiencing existing and emerging common trends: declining grassland songbirds, species at risk conservation, push for increased protected and conservation areas and

pressures like increased renewable (wind and solar) developments. Species know no boundaries, they do not adhere to provincial or country boundaries, thus the need to work together to preserve their native landscapes.

As the Transboundary Grassland Partnership continues to evolve and grow with increased interest and participation, we continue to connect people to people to landscapes to improved native grassland conservation and begin bridging boundaries.

THE SOUTH DAKOTA MODEL FOR GRASSLAND CONSERVATION: PRODUCER-BASED CONSERVATION AND MANAGEMENT

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Approximately 50% of South Dakota is grassland and over 90% is privately owned. Any comprehensive approach to influencing the extent and health of these grassland communities will be based on producer-driven conservation and management. The South Dakota Grassland Coalition (Coalition) is now in its 20th year. The core of the Coalition business model is built on producers educating other producers about profitable and sustainable ranch and farm management that promotes grassland health. Coalition members understand that grass is their crop and that livestock are the way they harvest and market it. Management that promotes healthy grasslands increases livestock gain and soil health. Diverse native grassland communities help reduce the effects of drought, and often require fewer inputs of insecticides and herbicides by keeping the ecological system intact. A healthy functioning ecosystem balances the void that often occurs when managers treat symptoms instead of the cause of problems like weeds or low production.

Although many producers have an emotional tie to ranching, long-term, broad-scale grassland conservation in South Dakota will only occur if preserving grasslands is as profitable as other land-use alternatives. The goal of the Coalition is to help grass-based producers, or those seeking to reintegrate grassland into their operations, become more profitable by using ecosystem principles to work with rather than against nature to enhance their soil and plant communities, thereby reducing input costs and increasing long-term profitability and quality of life. Not only does holistic grassland management tend to increase long-term ranch profitability, it also has the potential to provide societal benefits like enhanced water quality, increased wildlife populations and decreased carbon emissions.

Education - Each year, the Coalition presents nearly 40 classes, workshops and tours from several hours to several days in duration to over 600 individuals, for a total of almost 6,000 hours of education. These events are targeted primarily at agricultural producers but are equally popular with agency conservation professionals. Many events feature producers showcasing their own unique approaches to grassland, livestock and whole ranch management challenges. Coalition Grazing Schools present a comprehensive survey of holistic grassland management principles balanced with field exercises on grassland restoration, stocking rates, livestock rotation, grass and forb identification and grassland monitoring. Every Coalition event is intended to meet producers where they are in adopting holistic management, predicated on each producer's unique objectives for their soil, grasslands, livestock, business and life style. Most importantly, each event celebrates innovation and

progress in sustainable and profitable management and is designed to foster student-mentor relationships. In addition to group events, the Coalition has recently launched a program of intensive consultations between trained holistic management practitioners and ranchers that have attended one or more grazing schools, culminating in a ranch management plan.

Outreach - Unfortunately, even in a rural state like South Dakota, many residents do equate healthy landscapes with public health and quality of life due to basic ecosystem services. Moreover, many people are more familiar with farming than ranching. They are unaware that the same agricultural safety net that supports conventional farming is frequently disadvantageous to ranching, and may inadvertently lead to environmental degradation. The Coalition outreach program is designed to educate the public about the role healthy, diverse grasslands play in delivering societal values including soil health; moderating the volume and increasing the quality of runoff into the State's streams, rivers and lakes; producing abundant wildlife; reducing net carbon emissions; and sustaining vibrant rural communities. The Coalition has conducted dozens of interviews with ranchers using holistic practices to manage their grasslands. These interviews are used to demonstrate the benefits of healthy grasslands through social media posts, television and movie trailer commercials, and feature articles in print and on-line.

Besides reaching the general public, Coalition outreach also engages state and national elected officials, government administrators and industry leaders, educating them about healthy grasslands, the benefits of holistic management, and the opportunities for government programs, agricultural lenders and industry to support environmentally friendly ranching in ways that benefit constituents and consumers. Coalition members, as producers deriving their income directly from agriculture, are in an unparalleled position to speak to these leaders.

Partnerships - Every educational event and outreach tool produced by the Coalition is directly underwritten by an array of partners. The Coalition is a nexus for grassland conservation in South Dakota and the Northern Great Plains and the relationship between the Coalition and its partners is symbiotic. Partners enable all the Coalition activities, and, in-turn, the Coalition makes it possible for partners to achieve their grassland conservation goals. These conservation goals cannot be achieved without producer buy-in.

Coalition partners include state and federal government agencies and conservation NGOs. Partners recognize the power of producer-to-producer education about the importance and means of enhancing grassland health. Partners are encouraged to use every outreach tool produced by the Coalition for their own outreach. Future expanded partnerships are expected to engage individuals through donations to a Grassland Conservation Endowment that will partially fund Coalition staff and activities.

Members of the South Dakota Grassland Coalition believe that future large-scale conservation of grasslands will be based on producers conserving healthy grasslands because it is their own interest to do so, sometimes referred to as "sustainable, self-interested grassland management." Only healthy grasslands can sustain profitable ranching over the long-term, and only ranching can ensure the continued existence of expansive privately-owned grasslands.

ENGAGING AND ASSISTING THE STEWARDS OF AMERICA'S GRASSLANDS: AUDUBON'S CONSERVATION RANCHING INITIATIVE AND OTHER WORKING LANDS PROGRAMS

Josh Lefers, Working Lands Program Manager, Audubon Dakota

The National Audubon Society was established by influencing the market in the name of conservation. In the late 1800s, a group of citizens united to protest the unmitigated slaughter of waterbirds for their plumes,

which were used in ladies' fashion. Early Audubon Society members realized that their conservation goal could only be attained though a change in the market demand. They supported fashion that excluded plumes, and used the power of their purchase to make a difference. Today, the National Audubon Society strives to make the connection between conservation and the marketplace once again. The ACR program connects conscientious consumers to ranchers that employ bird-friendly management techniques through a third-party verified certification program.

Birds are an important indicator of overall ecosystem health, and grassland bird population trends have shown a 40% decrease since 1966, with declines ongoing in many species (NABCI 2017). Grasslands and the birds that depend on them are in trouble. Grasslands are under threat from conversion to cropland, urban development, invasive species, woody encroachment, incompatible grazing, energy development, indirect effects of modern agriculture, and fragmentation from each of the above factors. This complex of factors leads us to the question "How can we affect significant, lasting changes at scale to address the threats to grasslands and grassland nesting birds?"

This conservation concern is not new. In 1942, Audubon Magazine carried an article from Aldo Leopold, wherein he was quoted saying "*"Dairy X buys milk from (farmers with) steep eroding pastures, which spill floods on the neighbors, and ruin streams...it also buys milk from careful farmers, and mixes the two, so that conservation milk is indistinguishable from exploitation milk."* Leopold proposed, *"Hitching conservation directly to the producer-consumer relation…if we don't like the way Landowner X is using the natural resources of which he is owner, why do we buy his products? Why do we accord him the same social standing as landowner Y, who makes an honest attempt to use his land as if he were its trustee?* (Leopold, 1942)

The vast majority of grasslands are privately owned or operated, and those grasslands are commonly used for livestock production. Habitat loss, therefore, is inextricably linked to our food system. In response to the urgent need to maintain grasslands, Audubon created the Audubon Conservation Ranching Initiative (ACR), which aims to improve the ecological functions of grassland ecosystems by enlisting and assisting America's ranchers in the Great Plains and the American West.

Audubon representatives develop habitat management plans for enrolled ranches, guided by regionally appropriate practices. These practices fall under four categories: habitat management, forage and feeding, animal health and welfare, and environmental sustainability. These ranches are then monitored for avian and vegetation response to habitat enhancement, providing a feedback loop to positively affect management into the future.

The beef and bison products from those ranches are eligible to be labeled with the "Grazed on Audubon Certified Bird-Friendly Land" seal, and informed consumers can stimulate conservation through everyday food choices. This "beef with benefits" empowers consumers and rewards good ranching practices. With wide-ranging ecosystem benefits, ACR charts a path to a more sustainable future.

To assist enrolled ACR ranchers and other private landowners in implementing bird friendly management practices Audubon Dakota has developed the Prairie Management Toolbox. This program offers cost share opportunities to landowners to manage their land with tools such as prescribed fire, prairie restoration, invasive species removal and grazing infrastructure establishment. The program addresses specific local avian and habitat conservation needs, and is currently serving five counties in North Dakota.

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10. CONTINENTAL SCALE AND LARGE LANDSCAPE APPROACHES TO GRASSLAND CONSERVATION

A CONTINENTAL (GREAT PLAINS) APPROACH TO GRASSLAND CONSERVATION

Cliff Wallis, Alberta Wilderness Association, Nature Canada and Great Plains Conservation Network

There is a long and proud history of grassland conservation work on the Great Plains that started with more curious and progressive ranchers and a few conservation organizations that were willing to do the heavy lifting. Global collaboration through the Temperate Grassland Conservation Initiative promoted communication among practitioners and led to the Hohhot Declaration (IUCN 2008). At a trinational level, Canada, USA, and Mexico have undertaken government-led efforts through the Commission for Environmental Cooperation involving multistakeholder communication, pilot projects, and policy recommendations. It was also very active in the past holding meetings and funding several publications, e.g. Commission for Environmental Cooperation (2001, 2013); Commission for Environmental Cooperation and The Nature Conservancy (2005); and Gauthier et al. (2003). More recently there have been trinational grassland conservation discussions (Michael Gale, US Fish and Wildlife Service, personal communication).

At a national level, governments and NGOs in the USA and Canada have started to focus again on grasslands. World Wildlife Fund USA has been very active in the northern Great Plains. The U.S. National Fish and Wildlife Foundation has funded numerous projects and the National Wildlife Federation has started discussions of a Great Plains Initiative. In Canada, the federal government is working with the provinces to achieve Target 11 (Convention on Biological Diversity 2010) to protect 17% of Canada by 2020--one focal area is grasslands since it is one of the most underrepresented biomes in protected area systems.

There are also tribal-led groups, not necessarily with a grassland focus but supportive in the context of grassland conservation. These include the Native American Fish and Wildlife Society which undertakes knowledge sharing as well as the work around the Buffalo Treaty/Iiinii Initiative and multiple tribal commitments to bringing back bison in the grasslands.

There are many regional and local initiatives, with either a producer, issue or geographic focus, such as the Transboundary Grassland Partnership, Sage Grouse Initiative, and Ranchers Stewardship Alliance, as well as numerous Watershed Councils and Soil Conservation Districts. Not all are grassland focused but many are generally supportive of grassland conservation efforts.

There are many delivery vehicles in government led initiatives (e.g. Joint Ventures) as well as numerous NGO projects. There is even increasing cooperation across boundaries in the Joint Ventures. There is uncertainty about the viability of some work due to cutbacks, for example, Landscape Conservation Cooperatives and even the wildly successful Sage Grouse Initiative.

Unfortunately, there is still minimal coordination/strategizing regarding advocacy for protection of the largest blocks plains-wide. There is an ongoing need for conservation priority setting, state of the grasslands reporting (e.g. WWF's plowprint), advocacy for protection and policy tools to assist (e.g. legislation such as the Farm Bill). Protection can come in many forms from voluntary conservation agreements to

legislated protection. We need all the tools in the toolkit. Fundamentally, landowners need to feel rewarded for the work they are doing to protect wildlife and conserve grassland habitat. Some grassland stewards have felt punished due to increased scrutiny of their lands and regulatory oversight with no or minimal societal compensation for the ecological goods and services they provide.

There were several Landscape Conservation Cooperatives (LCCs) that fit quite nicely into work that was happening in the Great Plains. LCCs were agency/multistakeholder-led applied conservation-science partnerships between federal agencies, states, tribes, NGOs, universities and other stakeholders. They informed resource management decisions and helped with larger policy goal setting.

Like the LCCs, Joint Ventures are what I term agency and multi-stakeholder-led initiatives and several also fit into the Great Plains boundaries, however you define them.

Although the Joint Ventures have limited staff, they do a lot of good work on grassland conservation. There is a heavy agency and bird focus but there are many partners (state, provincial, federal, NGOs, industry) that can deliver on the ground. One could term this landscape-scale conservation but we still have a long way to go before we can feel secure in meeting targets for conservation that will stem further declines in multiple species groups. Joint Ventures help with habitat restoration and management. There seems to be minimal involvement of advocacy groups in some Joint Ventures but they are present in some.

At a regional level there have been numerous NGO-led initiatives. In Canada, most importantly, there is the Alberta Prairie Conservation Forum and the Saskatchewan Prairie Conservation Action Plan Partnership. These had their roots in the 1988 WWF Canada's "Prairie for Tomorrow" Program. With minimal staff, they remain focused on grassland conservation, particularly at a landscape level and with an eye to connectivity, species at risk, multistakeholder communication, policy recommendations/action plans, and mapping. There is government agency, producer, industry and advocacy group involvement.

More recently we have seen the formation of the Transboundary Grassland Partnership working in northern Montana, southeastern Saskatchewan and southwestern Alberta. It also involves government and multiple stakeholders. There is a focus on communication and is in the process of priority setting. It is holding its fifth annual meeting this winter in Saskatchewan. There is no dedicated staff for this although some staff time is allocated from other NGOs for the work.

There are many NGOs and conservation ranchers working across the Great Plains from Canada to Mexico. They are both large and small, delivering conservation in its myriad forms across this landscape. As an example, in Chihuahua there are Mexican NGOs as well as other American NGOS like Bird Conservancy of the Rockies, Natural Resources Defence Council, World Wildlife Fund and others doing great work with local ranchers here.

Last but not least are producer-led and producer-influenced networks and NGOs, for example, South Dakota Grasslands Coalition, Ranchers Stewardship Alliance Inc. (Saskatchewan), Ranchers Stewardship Alliance (Montana), and the Thunder Basin Grasslands Prairie Ecosystem Association, some working at the local level. There are a wide variety of innovative approaches, some with a heavy science basis and they will continue to be critical to the success of conservation in the Great Plains.

Other such networks which are less focused on grasslands but which sometimes are supportive of grassland conservation are the various Watershed Councils and Associations of Conservation Districts (including Tribal Conservation Districts). There may be a soil or water focus but there is often some attention to other natural resources. There is somewhat of a multi-stakeholder approach with a landowner/industry implementation focus.

One of the most well-known and successful initiatives has been the Sage Grouse Initiative in the USA. It is agency-led but multi-stakeholder influenced. It is science-based with a strong producer focus. It has been well-funded and there is extensive staff with good

communication. It has a wide reach across the west well beyond the Great Plains boundary.

The NGO-led collaboration--the Great Plains Conservation Network (GPCN) has a focus on large grassland landscapes, connectivity and species at risk. It grew out of the Northern Plains Conservation Network (NPCN) that re-formed in 2001 and raised awareness about grassland conservation over the past two decades. With World Wildlife Fund USA doing the heavy-lifting, NPCN produced "Ocean of Grass", a blueprint for conserving the Northern Plains in Canada and the USA. NPCN also coordinated advocacy that its participants undertook, for example, related to Bureau of Land Management Plans, protection of PFRA Pastures, and bison reintroduction. NPCN hosted initiatives related to birds and bison and undertook field tours and face to face meetings. NPCN had a part time coordinator until 2017.

The need for collaboration across the northern plains was highlighted at a meeting in 2016 that was hosted by the Margaret A. Cargill Foundation and the National Fish and Wildlife Foundation. They funded an NPCN survey of participants and other practitioners in 2017. At the NPCN workshop at America's Grasslands Ft. Worth Conference in 2017, participants suggested expanding NPCN's reach to cover the entire Great Plains from Canada to Mexico. Some of the successes of NPCN as determined from the survey were the increase in visibility of region to decision-makers with some differences made on the ground. The Listserve has been newsworthy and not overwhelming. Participants wanted to know about funding opportunities and to work on policy changes.

There is increasing alignment of agency/ multistakeholder-led, producer-led, tribal-led, and ENGO-led interests when it comes to "large" area or landscape level grassland conservation. There has been long-term funding to support the work of NPCN and now GPCN from its key participants, but it has not been enough to sustain staff dedicated to coordination of this effort.

Some of the elements of landscape-scale grassland conservation are being met elsewhere, for example, Sage Grouse Initiative and Joint Ventures. A Central Plains Bird Summit is being planned for August 2020 in Denver, Colorado, USA.

NPCN morphed into GPCN this past February after those suggestions from the last America's Grassland conference. There is no current GPCN staff. GPCN expansion to whole Great Plains has enhanced participation on the steering committee. We still need to do more outreach for Mexico and tribes/First Nations. It may be a lot to ask of a volunteer group but past NPCN successes say it can help in the big picture of Great Plains conservation. Remember that better is good. We never get perfect.

So what is the Great Plains Conservation Network's mission? In a nutshell, with tools to support conservation work and adopting mechanisms to exchange ideas and coordinate action, GPCN works to restore North America's grasslands and ensure the continued survival and health of its wildlife, wildlands, and human societies. GPCN is a network of groups and individuals who support, promote, and work together to implement the GPCN vision. It is not a legal entity. It has adopted a structure composed of the larger network of participants, a steering committee, and working groups that are created on an as-needed basis.

The Great Plains Conservation Network is all about the future of a grassland landscape that supports a tremendous diversity of life and the many families that depend on its well-being.

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BIODIVERSITY HOTSPOTS IN THE CENTRAL AND SOUTHERN GREAT PLAINS

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We hypothesize that important areas of intact grasslands remain in the central and southern Great Plains that function as current or potential biodiversity hotspots. As part of a large-scale effort, the Great Plains Conservation Network, we seek to identify these areas. We are looking for opportunities for large-scale conservation of intact (or potentially restorable) prairie ecosystems. For example, lands that are large enough to support bison herds *(Bison bison),* or black-tailed prairie dog complexes *(Cynomys ludovicianus),* in which to establish self-sustaining black-footed ferret populations *(Mustela nigripes).* This analysis is a first step in identifying and ultimately protecting these lands.

To select target areas, we first took a course filter look at human impacts on prairie ecosystems. We examined habitat fragmentation from roads and crop agriculture via the World Wildlife Fund Plowprint analysis (Gage et al. 2016), to determine at the continental scale where opportunities might exist. From there, we determined that the greatest opportunities exist in the short- and mixed-grass prairie. We further identified concentrated opportunities in the central shortgrass prairie region of eastern Colorado, southwestern Wyoming, southwest Nebraska, western Kansas, the panhandle of Oklahoma, and northeastern New Mexico (Figure 1). Therefore we concentrated our more detailed analysis in this region.

Within the central shortgrass prairie region, we took a more detailed look at human impacts. We used a fragmentation index (Augustine 2020) and climate resiliency dataset (Anderson 2016) to map human impacts, and their inverse, conservation opportunities. Furthermore, we then limited our suite of potential conservation areas to those larger than 5,000 acres, producing a detailed map of large-scale conservation opportunities in this region (Figure 2).

Figure 2 indicates excellent opportunities for shortgrass prairie preservation in southeast Colorado. Southeast Colorado includes the Comanche National Grasslands, which are recognized as a Key Biodiversity AreaTM. This area contains the Colorado Natural Heritage Program's Purgatoire Canyon, Purgatoire Prairie, and Purgatoire River and Tributaries Potential Conservation Areas, all of which are ranked as having Very High Biodiversity Significance (Rondeau et al. 2010). The Nature Conservancy and the Colorado Natural Heritage Program consider southeast Colorado to be the most intact area

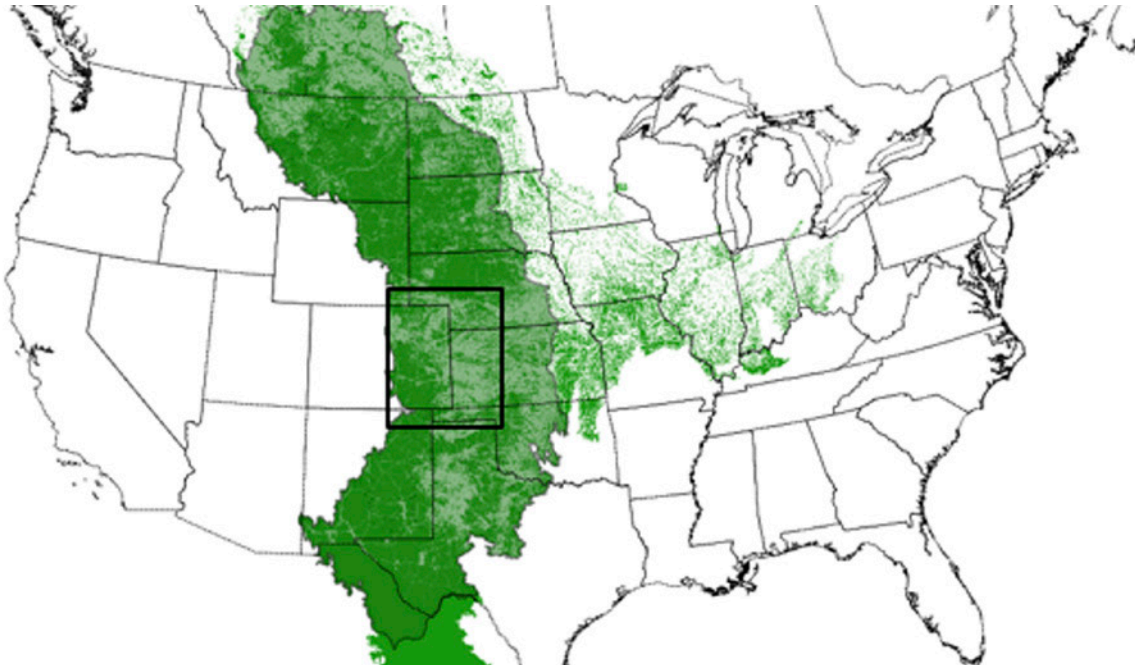

Figure 1: Fragmentation from roads and agriculture (WWF Plowprint/Gage et al. 2016), showing high potential conservation areas in the short- and mixed-grass prairie (dark green), and specifically in the central shortgrass prairie (black box).

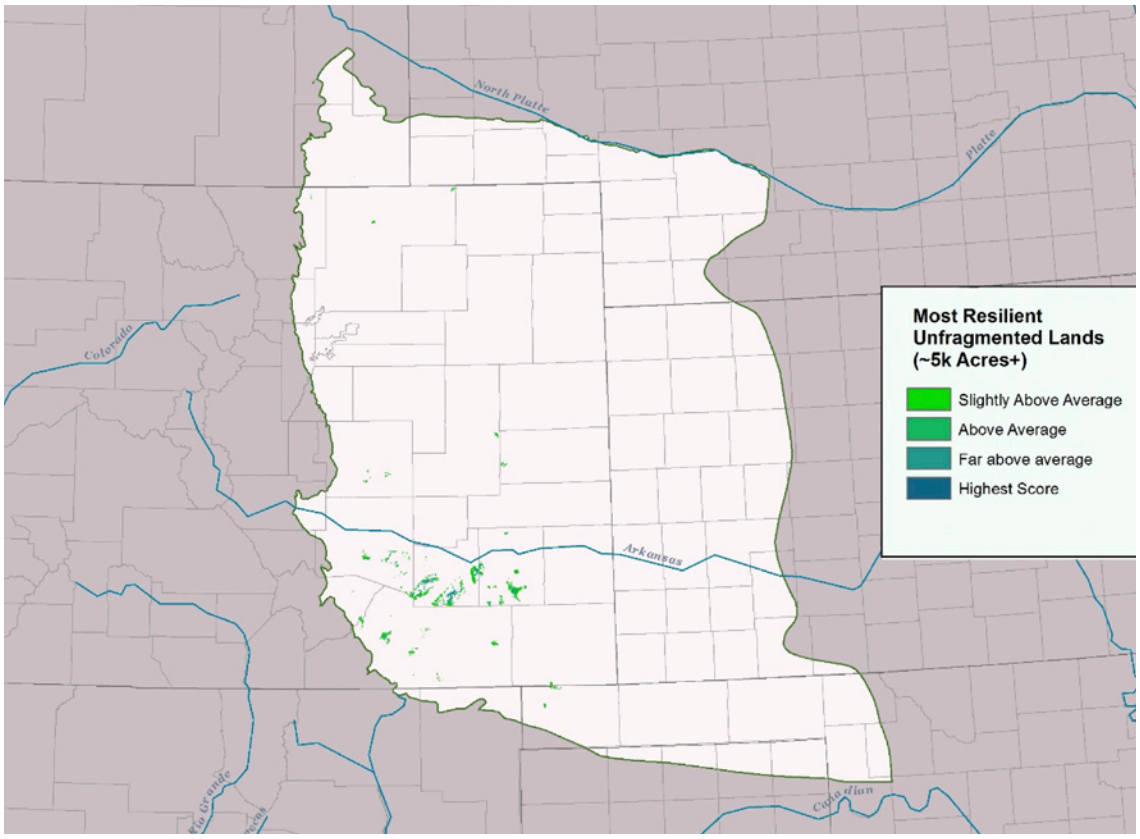

Figure 2: Most resilient and unfragmented lands greater than 5,000 acres in the Central Shortgrass Prairie.

within the ecoregion (Neely et al. 2006, Rondeau et al. 2010). Scientists describe it as a biodiversity hotspot given its topographic diversity, high concentration of endemic species, and its intersection of species ranges from the Chihuahuan Desert, Southern Plains, and Central Shortgrass Prairie (Rondeau et al. 2010, Savage 2011).

The wide variety of habitats found here include short- and mixed-grass prairies, shrublands, rivers, canyons, shale barrens and hills, juniper savannas, and woodlands. The juniper breaks, shale barrens, and escarpments in the area are rare in Colorado and provide vital habitat for four of Colorado's endemic plants (Rondeau et al. 2010). Seeps and springs within the canyonlands provide habitat for almost all of Colorado's rare ferns. Overall, there are high numbers of rare flora and fauna in southeastern Colorado, including at least 41 rare animal species and 36 rare plant species, as well as 46 plant communities for which there is conservation concern (Id.).

The Comanche National Grasslands significantly contribute to the intactness of the area. These federal lands are managed by the U.S. Forest Service and lie in two blocks covering a total of approximately 440,000 acres. The Comanche includes shortgrass prairie expanses, the Purgatoire River and associated canyons, and a variety of topographic relief. This national grassland is the largest area of publicly accessible federal lands in the southern Great Plains.

However, despite these large public land-holdings, a variety of uniquely North American species that are native to the region are in desperate need of increased protection and, in some cases, reintroduction due to historic extirpation. These species include the American bison, American pronghorn *(Antilocapra americana),* black-tailed prairie dog, black-footed ferret, and the lesser prairie-chicken *(Tympanuchus pallidicinctus).* A broader ranging North American species, the North American beaver *(Castor canadensis),* has likewise experienced reduction throughout the region.

Private land acquisition to create wildlife refuges is a plausible and effective biodiversity protection strategy that can be readily implemented in this region. It is vital to reverse the pattern of native species extirpations and population suppression, which has impeded the ability of keystone species to perform their ecological functions. It is also important to prevent the conversion of native grasslands to crop agriculture, energy development, and other land uses that would irreversible alter shortgrass prairie plan communities. The fact that the establishment of private wildlife refuges is already occurring in this area, by organizations such as the Southern Plains Land Trust (SPLT), is evidence of the feasibility of this conservation approach.

We envision that these successful mechanisms for conservation that have been applied by SPLT can also be applied to other lands identified through our analysis, creating a network of large-scale lands focused on conservation within the short and mixed grass prairie ecosystems.

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CONSERVATION ACROSS BORDERS: SMALL ENVIRONMENTAL NGOS WITH BIG IDEAS

Branimir Gjetvaj, Public Pastures - Public Interest

Public Pastures - Public Interest (PPPI) is a Saskatchewan-based education and advocacy group formed in 2012 by dedicated urban and rural citizens concerned by the Canadian federal government's decision to divest the Community Pasture Program run by the former Prairie Farm Rehabilitation Administration (PFRA). PPPI represents a network of local and international individuals and organizations working for the preservation and sustainable use of Crown grasslands in Saskatchewan.

Over the last 7 years, PPPI has formed productive relationships with many stakeholders such as environmental NGOs, Indigenous peoples and organizations, ranching and heritage groups. We engage our supporters by hosting public events and discussion forums. PPPI advocacy work involves promotion of letter-writing campaigns, communication through traditional and social media, and communication with elected officials.

PPPI was successful in influencing public retention of some Saskatchewan native grasslands. We initiated a petition that was tabled in the Canadian Parliament by MP Wayne Stetski, calling on the federal government to work with livestock producers, First Nations and Metis groups, local communities and environmental NGOs to restore conservation programming to the former federal community pastures (https://petitions.ourcommons.ca/en/Petition/Details?Petition=e-927, accessed on 15. September 2019). In part due to pressure from PPPI and other environmental NGOs, a land swap was arranged to return the management of three large former PFRA pastures in southwest Saskatchewan: Govenlock, Nashlyn and Battle Creek, to federal government control. A single, 160,000 acre continuous block of highly biodiverse grasslands will be managed to minimize impacts on wildlife, while providing for the needs of grazing operations (https://www.producer.com/2019/07/ pasture-swap-operates-under-temporary-arrangement, accessed on 10. September 2019). PPPI continues to advocate for retention of publicly-owned grasslands as Crown land, and for creation of an up-to-date grasslands inventory for the province. We call for the securement of federal and provincial technical capacity for protection of ecological, cultural and heritage resources on community pastures in the province.

There are approximately 8.5 million acres (3.4 million ha) of publicly-owned grasslands in Saskatchewan, used for cattle grazing and hay production. This includes land originally in federal and provincial community pasture programs, as well as agricultural Crown land leased to individual cattle producers (Phillips, 2015; Government of Saskatchewan, 2017). The Crown land on federal and provincial community pastures in Saskatchewan comprises some of the largest intact blocks of the original native grasslands in the Northern Great Plains of Canada (Phillips, 2015).

The rangeland on former PFRA pastures used to be managed for cattle production, providing economic benefit to the producers, and to ensure suitable habitat for species at risk that depend on healthy prairie landscapes (AAFC-PFRA, 2007). The PFRA pastures were considered a goal-standard for the sustainable management of rangelands on Canadian prairies.

A total of 32 prairie species considered at risk in Canada have been reported on the former PFRA pastures (Phillips, 2015). In 2012, the federal government started to divest the Community Pasture Program run by the PFRA / AESB and transfer the management of former PFRA pastures to the Government of Saskatchewan (Phillips, 2015). By transferring ownership and management from federal to provincial jurisdiction, the federal Species-at-Risk Act (SARA) will no longer effectively apply on these lands. The Government of Saskatchewan established its own laws to classify and protect species at risk. However, the provincial legislative framework does not provide adequate nor effective protection for a majority of threatened species (Olive, 2018; Doke Sawatzky, 2019). The loss of protected areas is not unique to Saskatchewan. Worldwide, thousands of protected areas have been downsized or degazetted, i.e. no longer protected by law or formal agreements (Visconti et al., 2019).

Large protected areas that are managed for the long-term conservation of nature are a cornerstone of biodiversity conservation. They provide suitable space for species that are susceptible to disturbances or habitat fragmentation. Nevertheless, species populations within and outside protected areas continue to decline (Le Saout et al., 2013; Visconti et al., 2019). Even large parks and protected areas will continue to lose species over the long term if they are isolated from one another by unsuitable habitat. For example, many migratory species use habitats that are outside protected areas for a large part of their life cycle. Focusing on a large protected-area conservation strategy alone will not be sufficient without including conservation efforts to protect surrounding small, often isolated habitat patches (Lindenmayer, 2019). This is particularly important in heavily modified, human-dominated landscapes such as agricultural lands.

The effectiveness of protected areas is significantly influenced by the type of land management of surrounding land. A complex matrix of wildlife-friendly landscapes established through "working-land conservation" (Kremen and Merenlender, 2018) will complement protected areas by providing necessary habitat for some species, while facilitating dispersal and adaptation to climate change for others. Efforts to increase heterogeneity of agricultural landscapes where land use and management practices complements biodiversity goals of protected areas and provision of goods and services should be an important component of biodiversity conservation strategies (Landis, 2017; Kremen and Merenlender, 2018). By focusing more attention on functional diversity of ecosystems and not just on species diversity through large protected area networks, we might be able to design and manage agricultural landscapes for delivery of biodiversity-based ecosystem services (Geertsema *et al*., 2016; Gawith and Hodge, 2019)

In a similar fashion, we should aim to form diverse cooperative networks between small, voluntary grassroots organizations and social movements, with well established large environmental NGOs. When we talk about continental-scale conservation, we often think of creating networks based on geographic boundaries. The sheer diversity of interests and goals present among small environmental NGOs and community-driven conservation initiatives, provide a fertile ground for a different type of continental-scale alliances. Furthermore, conservationists should not forget to listen to, and embrace societies that practice traditional knowledge and alternative ways of knowing,

Current rates of land use and human-induced climate change are wrecking havoc on the environment and associated biodiversity. Only through a continental-scale cooperation unhindered by societal and jurisdictional boundaries, we will be able to tackle the greatest threat facing the Anthropocene: unsustainable land use, biodiversity loss and climate change.

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ADVANCING WILDLIFE CONSERVATION ACROSS THE GREAT PLAINS

Seth Gallagher, National Fish & Wildlife Foundation

Other authors: Ian Davidson, Chris West, National Fish & Wildlife Foundation

Recognizing the importance of grassland and sagebrush landscapes, National Fish and Wildlife Foundation (NFWF) has ramped up its investments in wildlife conservation across the central and western United States through targeted programs in the Northern Great Plains, Pecos Watershed and Sagebrush landscapes. This presentation will highlight the current status of NFWF's conservation investment strategies and discuss its future directions in each of these focal landscapes.

NATIONAL GRASSLANDS MANAGEMENT: AN EXAMPLE FROM THE NORTHERN GREAT PLAINS

Dan Svingen, USDA Forest Service

The United States' 20 National Grasslands encompass 3,800,000 acres in 12 western states. These lands are managed for multiple-uses. In this presentation, I described how that is accomplished on the 116,000-acre, mixed-grass prairie-dominated Fort Pierre National Grassland (FPNG) in central South Dakota.

Management of the FPNG is guided by the goals, objectives, standards, and guidelines specified in the relevant Land and Resource Management Plan (LRMP). The current LRMP (USDA Forest Service 2009) was adopted in 2002 and last updated in 2009. Initial development of that LRMP took 11 years, millions of dollars, and was very controversial (Sidle 2002). The primary point of contention was how various multiple-uses, particularly conservation, livestock grazing, and recreation; should be balanced. Public input was most extensive on the desired levels of livestock grazing and black-tailed prairie dog *(Cynomys ludovicianus)*, greater prairie-chicken *(Tympanuchus cupido),* and sharp-tailed grouse *(Tympanuchus phasianellus)* populations.

Conservation management on the FPNG focuses on maintaining or restoring diverse mixed-grass prairie habitat. The LRMP has management objectives for amounts of low-, moderate-, and high-structure vegetation as well as early, early-intermediate, late-intermediate, and late seral vegetation. Species-specific LRMP direction is most detailed for the black-tailed prairie dog, greater prairie-chicken, and sharp-tailed grouse.

Vegetative management on the FPNG is primarily done through prescribed fire and prescribed livestock grazing. Prescribed fire occurs most years, with the majority of treatments being applied in April and May. From 1998-2018, an average of 650 acres was burned annually.

Prescribed livestock grazing occurs on 90% of the FPNG each year; the remaining 10% of the FPNG is rested, with treatment locations changing yearly. The majority of permitted cattle are grazed using a modified deferred rotation system. From 1998-2018, an annual average of 50,000 animal unit months (AUM) was authorized. Stocking rates over the same period averaged 2.0 acres/AUM; forage utilization rates varied widely, with 30%-40% being typical.

There are approximately 20,000 recreational site visits each year on the FPNG. The most popular pursuits are: prairie dog shooting, birding, prairie grouse hunting, and fishing. Recreational use increases in: January (ice fishing), April-June (birding, then prairie dog shooting), and September-October (prairie grouse hunting). Management for recreational uses is focused on providing and maintaining access routes and information.

Monitoring efforts include collecting data on: prairie dogs, prairie grouse, vegetative composition, and vegetative structure. Data is shared with the public and key stakeholders, including: grazing permittees, Lower Brule Sioux Tribe, and the South Dakota Department of Game, Fish and Parks. The information developed through this process is used to adjust land management for the following year.

Despite the arrival of plague into local prairie dog colonies in about 2012, monitoring shows that prairie dog populations are currently within LRMP objectives. Specifically, a prairie dog colony complex is present within the northeast portion of the Grassland, and there are between 1,000 to 3,500 acres of active prairie dog colony within the interior management zone (i.e. interior National Forest System land more than 0.25 mile from adjacent private or tribal land). Over the last decade, an annual average of 30 acres of prairie dog colony has been poisoned to address unwanted encroachment onto neighboring lands.

LRMP objectives for stable to increasing populations of prairie grouse are also being met. Greater prairie-chicken numbers quadrupled 1998-2018, while sharp-tailed grouse numbers remained remarkably stable (Figure 1).

Vegetative structural diversity has increased in recent years. Efforts to accelerate livestock rotation out of early pastures and lengthen use periods in late pastures have been particularly successful in creating both more high-structure vegetation (in early use pastures) and low-structure vegetation (in late pastures). The LRMP's structural diversity objectives were met in 2017, and nearly met in 2018 (Table 1).

Vegetative composition diversity objectives are no longer being met on the FPNG. Vegetative diversity has greatly decreased in recent decades due to the rapid and extensive spread of Kentucky bluegrass *(Poa pratensis),*

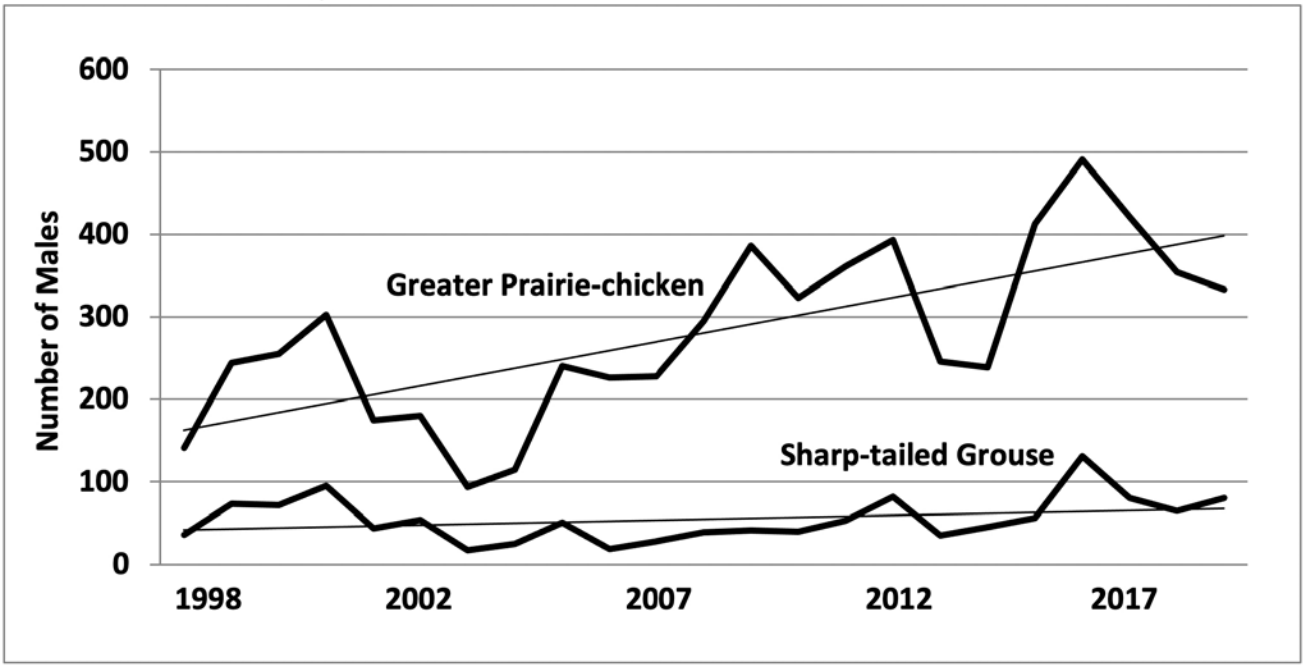

Figure 1. Total number of male greater prairie-chickens and sharp-tailed grouse tallied in the Cedar Creek Monitoring Unit, Fort Pierre National Grassland, 1998-2019.

Table 1. Percentage of randomly chosen Visual Obstruction Reading transects classified as low-, moderate, and high-structure vegetation on the Fort Pierre National Grassland, 2008-2018. Note: LRMP objectives are: 10%-30% Low, 30%-50% Moderate, & 30%-50% High.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
LOW	0	8	2	6	21	0	0	0	0	18	15
MODERATE	80	68	90	75	45	55	80	80	63	39	29
HIGH	20	25	8	19	33	45	20	20	38	42	56

smooth brome *(Bromus inermis),* and yellow sweetclover *(Melilotus officinalis).* These species covered about 5% of the herbaceous canopy in the 1980s, but dominant about 50% currently. The continued expansion of these exotics constitutes the leading proximate threat to the FPNG's ecological health. The increase in exotic vegetation, and subsequent loss of native vegetation, imperils the FPNG's future ability to support the current multiple-use mix.

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INNOVATION THINKING TO ACHIEVE THE GRASSLAND CONSERVATION WIG (WILDLY IMPORTANT GOAL)

James Giocomo, Oaks and Prairies Joint Venture

Other Authors: Kenneth Gee, Steven Riley, Willian L. Newman, Derek S. Wiley, Anna Matthews, Leah Lowe, Oaks and Prairies Joint Venture

Ramping up grassland conservation to meet existing and future conservation challenges will require strengthening of existing successful efforts and embracing new innovations in conservation. Innovation happens when we translate an idea or invention into a program or useful product that creates value or for our customers. In grassland conservation, our customers can include private landowners, downstream city residents, and wildlife populations. In many cases, we are trying to meet the needs of all three at the same time to meet landowner management objectives, increase overall ecosystem health, and improve habitat conditions for target plants and wildlife, creating a win-win-win situation.

There are many reasons why conservation efforts fail including lack of funding, lack of local support or buy-in, lack of understanding of local social, political, economic, and ecological conditions (present and historical) and finally lack of clearly state goals. These reasons for failure of conservation efforts are similar to common reasons why businesses fail. Bird Habitat Joint Ventures are self-directed partnerships of agencies, organizations, corporations, tribes, or individuals that have formally accepted the responsibility of implementing national or international bird conservation plans within a specific geographic area and has received general acceptance in the bird conservation community for such responsibility.

A key innovation of the Bird Habitat Joint Ventures (JVs) is a focus on conservation and management actions that are driven by bird population objectives. Instead of focusing solely on the outputs like number of acres managed, the JVs are forced to answer key questions like "how much is needed to meet the needs of target population?" instead of following a "more is better model." Knowing a stopping point allows the partners of the JV to track progress to the common goal based upon predetermined population based habitat objectives. That way JVs are tracking outcomes (wildlife population trajectories) as well as outputs (number of acres), instead of assuming more acres will mean increasing populations. This key innovation helps to clarify common goals that can incorporate social, political, economic, and ecological conditions. These goals can then be used to build local support and more clearly articulate reasons for investment in conservation strategies.

The Grassland Restoration Incentive Program (GRIP) is our Joint Venture signature conservation delivery program, and has improved habitat for grassland birds on over 85,000 acres of working lands in the Oaks and Prairies ecoregion in central Texas and Oklahoma. GRIP is supported by several innovative strategies including early support for landowner cooperatives, utilizing market-based conservation delivery strategies, and implement strategic outreach and communications. These strategies are intended to build local and regional buy-in by engaging a larger and non-traditional agency and non-profit partnerships throughout North America, in our case following the flyways of many declining migratory grassland birds from Canada to Mexico through 8 JVs in the Central Flyway.

Our scaling of efforts will also require innovative science advances, like Integrated Population Models that bring together traditional abundance models with range-wide productivity and survival measures to guide conservation efforts that address limiting factors for declining species. We plan to use these models to provide independently formed stakeholder conservation groups with expert guidance, involved mentoring, a network of peers, and financial resources to assist groups in becoming successful and effective organizations. We are mixing new ideas with old frameworks with an eye towards innovation at the tri-national scale.

11. GRASSLAND RESTORATION APPROACHES

WORKING IN SYNC WITH NATURE IN DESERT GRASSLANDS

Alejandro Carrillo, Las Damas Cattle Ranch and Pasticultores del Desierto

Millions of degraded acres of bare, unproductive, abandoned land is what represents today the largest deserts of the world, including the Chihuahuan desert. But this landscape has not always been that way. We humans, the way the manage these lands, without any respect for natural processes, are the main culprits of this degradation.

For millennia we fought and tried to dominate nature with brutal force …. Unfortunately, we are realizing it does not, and it will never work.

We have found that the only sustainable way of restoring vast degraded areas across North America is **working in sync with Nature.**

Nowadays we promote and use adaptive grazing management to mimic the migratory patterns of bison by frequently moving a big herd of tight, domestic cattle on small paddocks, then providing long rest periods for perennial grasses to establish and thrive. Cattle fertilize the soil, break the hardpan, clips the grass, so next time they will find better and more stands of grass.

Typical view of the Chihuahuan desert. Is this what the Spaniard conquistadors found when arriving at the Chihuahuan desert? We do not think so…

This is a spot within the Chihuahuan desert that has been restored to promote more and better perennial stands of grasslands. You can see sprangletop, sideoats gramma, black gramma, and some forbs.

The above picture is not a change of seasons, but a picture taken the same day on two neighboring properties under different management. The LEFT side is rotational grazing with too few cattle. The RIGHT side is intensive grazing with 3x more cattle per hectare.

Spring in the Chihuahuan desert. The results of applying a more intensive grazing makes the grass green up with very little water, despite neighboring properties being still in the dormant phase (farther spot)

This picture shows the tobosa grass under two grazing management approaches. The LEFT side uses adaptive grazing management at higher intensities. The LEFT side was grazed with too few animals. Ranchers doing adaptive grazing management will ended up with a much better leave-to-stem ratio as shown on the picture, promoting more leaves to stems.

Regarding fixing the water cycle, we can infiltrate up to 20 times more water into the soil using adaptive grazing, making ranching more resilient against drought, mainly due to the work done by dung beetles on the cow's manure. Dung beetles do half of the work of restoring grasslands.

Also, it is critical important to extend the green season to feed the micro herd (fungi and bacteria) with liquid carbon year-around.

In summary, we are supporting ranchers to:

- Increase biomass above and below ground
- Increase diversity of perennial grasses
- Increase infiltration rates
- Increase rest periods
- Increase pounds of beef produced per acre at lower cost
- Increase profitability and sustainability
- Improve quality of life for team members and their communities

COOL SEASON GRASS IMPACTS ON NATIVE MIXEDGRASS PRAIRIE SPECIES IN THE NORTHERN GREAT PLAINS

Kenneth E. Spaeth USDA-NRCS

Other Authors: Mark Hayek USDA-NRCS, David Toledo USDA-ARS, John Hendrickson USDA-ARS

The invasiveness of two principal cool season grasses, Kentucky bluegrass *(Poa pratensis L.)* and smooth bromegrass *(Bromus inermus L.)* has been well documented in the Northern Great Plains and is of concern as the dynamics of the native mixed grass prairie is changing. Community dynamics including diversity and composition changes, energy flow, hydrologic function, and nutrient cycling are impacted as a consequence of increasing composition of these invasive species. In addition to environmental changes,

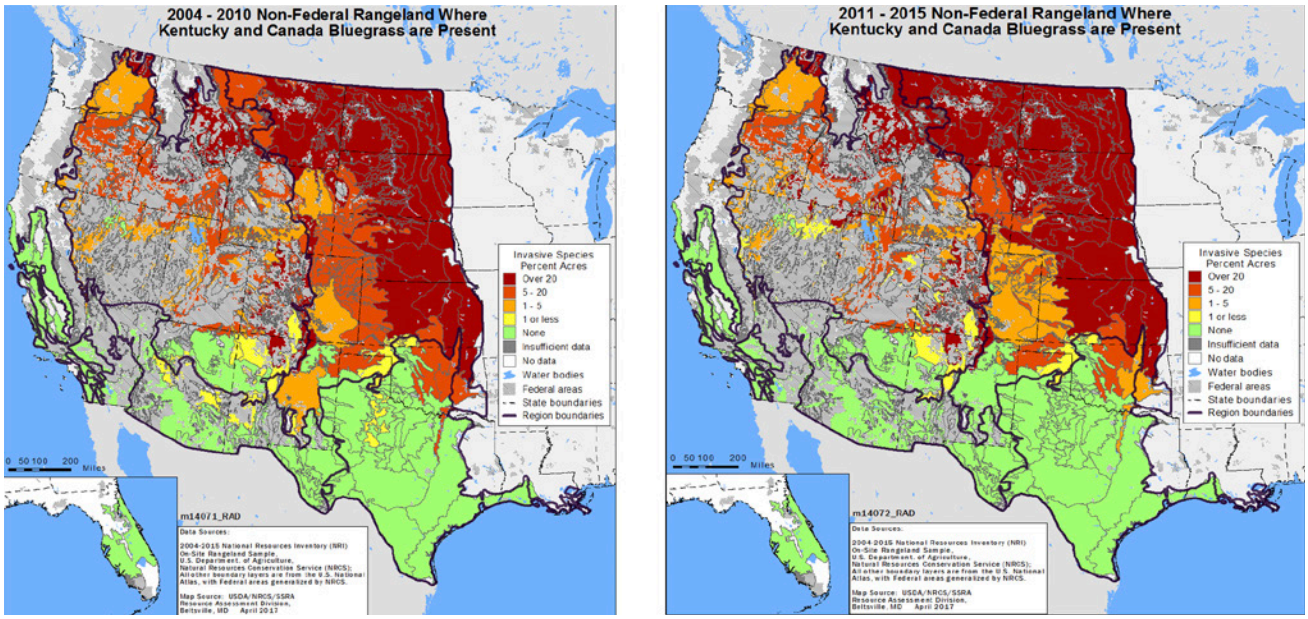

Fig. 1. Extent of Kentucky and Canadian bluegrass in the U.S. Color codes represent percentage of acres occupied.

Table 1. Extent of Kentucky bluegrass and smooth bromegrass in South and North Dakota (USDA-NRCS 2004-2014 NRI data set).

	North Dakota Rangeland Acres (1,000)	South Dakota Rangeland Acres (1,000)
Total RL acres	11,019	22,190
POPR>0% foliar cover	8,534 (77.5%)	12,240 (55.2%)
BRIN2>0% foliar cover	4,277 (38.8%)	5,880 (26.5%)
POPR/BRIN2>0 %	3,893 (35.3%)	4,862 (22%)

land use including grazing is also being affected. The USDA-NRCS National Resources Inventory data shows that a majority of ecological sites for mixed grass prairie across the Northern Great Plains now are host to and/or are dominated by these two grass species. Using the USDA-Natural Resources Conservation Service rangeland field Natural Resource Inventory study (2003 – 2015), this paper explores: 1) the current extent of these species, and 2) impacts on species diversity and composition with emphasis on important pollinator species.

Paper: Cool season invasive grasses have been increasing on Northern Great Plains rangelands (Toledo et al. 2014; USDA-NRCS 2018). Two commonly occurring cool season C3 non-native species, Kentucky bluegrass *(Poa pratensis L.)* and smooth bromegrass *(Bromus inermis Leyss)* are now prevalent. Both these species are tolerant to wide temperature extremes, drought, fire, and grazing. Both species are sod forming perennial grasses with rhizomes and are palatable to livestock and ungulate wildlife. Kentucky bluegrass is especially well adaptive as it reproduces sexually, asexually (vegetatively) and by facultative apomixis (Pseudogamous apospory). Chromosome number ranges from 18 to >156, is tolerant of fire and grazing, and can hybridize with other Poa species.

The data set used in this presentation is the USDA-NRCS rangeland National Resources Conservation Service field study (2004-2014). Field methodology for data collection is described by Spaeth et al. 2003, 2005,

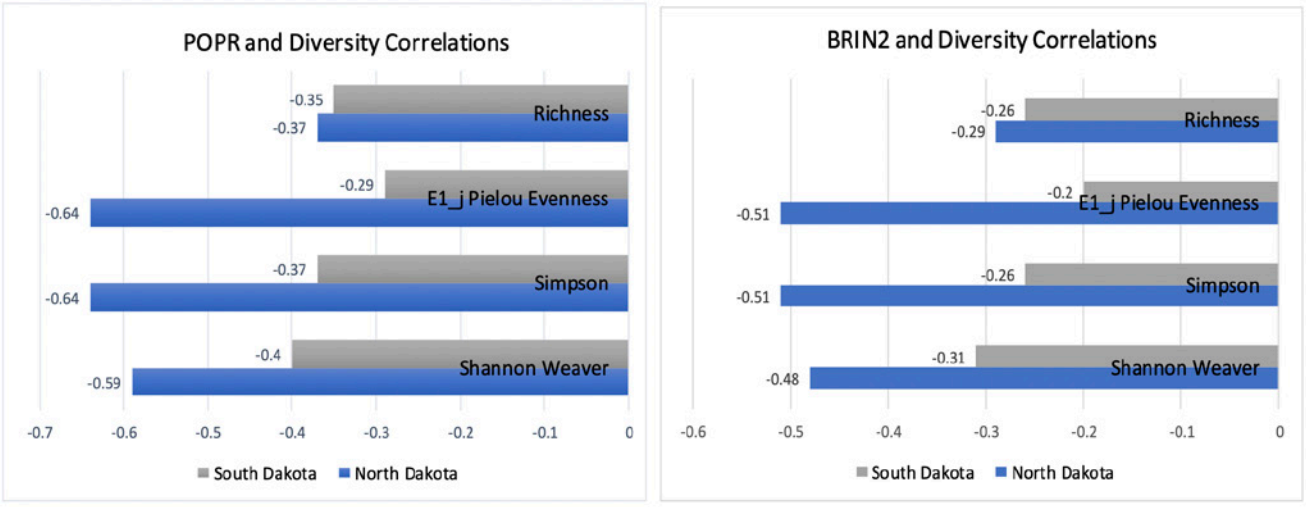

Fig. 2. Correlation of Kentucky bluegrass (Popr) and smooth bromegrass (Brin2) foliar cover with plant species richness, diversity (Shannon Weaver, Simpson indices) and evenness (Pielou evenness).

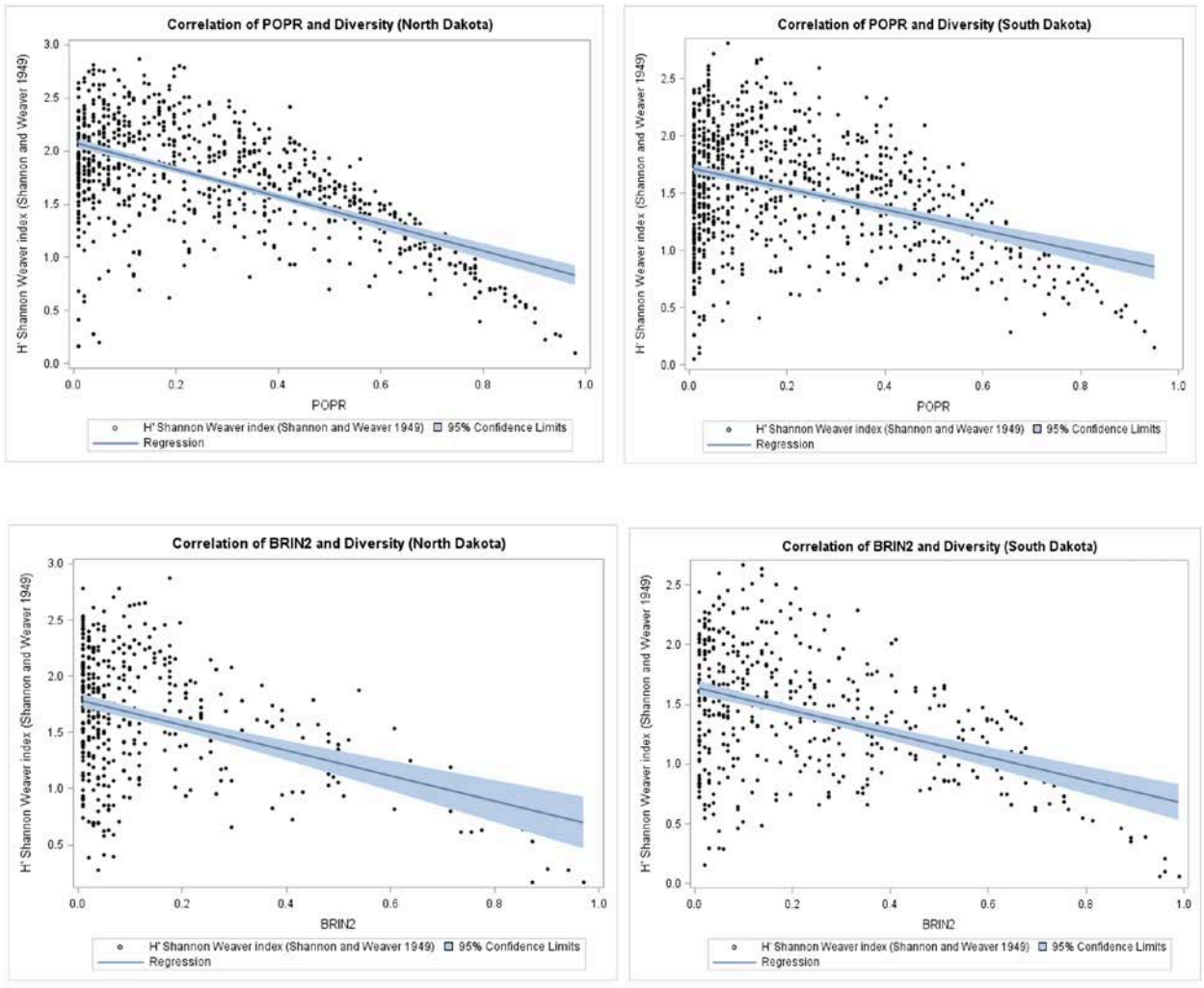

Fig. 3 Correlation with regression line of Shannon Weaver diversity index and increasing foliar cover of Kentucky bluegrass and smooth bromegrass.

and USDA-NRCS 2019. Although these two grasses are invasive throughout the Northern Great Plains (Fig. 1), this presentation is specific to South and North Dakota). Kentucky bluegrass is present on over half of the rangeland acres in both South Dakota (55.2%) and North Dakota (77.5%) and smooth bromegrass occupies 26.5% and 38.8% of rangeland acres in South and North Dakota (Table 1). In North and South Dakota, plant diversity changes are also significant with Kentucky bluegrass and smooth bromegrass invasion (Fig. 2, 3). As these species increase as a dynamic of foliar cover, species richness, evenness (Pielou eveness) and diversity (Simpson, and Shannon-Weaver) decrease in a linear fashion.

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THE ROLE OF THE USDA-NRCS PLANT MATERIALS PROGRAM IN INCREASING PLANT DIVERSITY IN GRASSLAND RESTORATION

Brandon Carr- USDA/NRCS James E. "Bud" Smith Plant Materials Center

The success of large-scale restoration depends on many variables, some of which are out of our control. One important variable within our control is the use of tested and proven seed sources. The USDA-NRCS Plant Materials Program was established to develop techniques for conservation planning and planting, to evaluate native plants for use throughout different regions addressing various resource concerns, and supply the commercial market with proven seed sources. The importance of plant diversity in healthy ecosystems is critical for grassland restoration. This presentation focused on the NRCS plant evaluation, selection and release process as well as highlighted the benefits of increased plant diversity in grassland restoration.

12. GRASSLANDS EMISSIONS, OFFSETS, AND ENERGY

CARBON OFFSETS TO FINANCE GRASSLAND CONSERVATION: THE CLIMATE ACTION RESERVE GRASSLAND PROJECT PROTOCOL V2.0

Beatriz Zavariz, Climate Action Reserve

Grasslands can both emit and sequester carbon dioxide (CO_2), the primary greenhouse gas (GHG) responsible for human-caused climate change.[1] Grasses and shrubs, through the process of photosynthesis, naturally absorb CO_2 from the atmosphere and store the gas as carbon in their biomass (i.e., plant tissues). As plants die and regrow, some of this carbon is also stored in the soils that support the grassland. When grasslands are disturbed, such as when the land is tilled for crop cultivation, a portion of the stored carbon oxidizes and decays, releasing CO_2 into the atmosphere. Through sustainable management and protection, grasslands can play a positive and significant role to help address global climate change.[2] Carbon offsets may provide financial resources to incentivize grassland conservation.

Carbon offsets represent GHG emissions reductions that have been achieved through voluntary implementation outside of capped sectors as a result of the financial incentives provided by the carbon market. High-quality offsets are real (they have been conservatively quantified), are additional (represent GHG reductions that would not have occurred in the absence of the carbon market), are permanent (their benefit persists in the atmosphere for at least 100 years), are verifiable (reviewed by a third party) and aren't double-counted (only claimed by one party at a time).

Founded in 2001, the Climate Action Reserve is a 501(c)3 nonprofit carbon offset project registry and climate policy organization. The Reserve has issued more than 136 million offset credits (tonnes of CO_2e) to hundreds of projects across the U.S. and Mexico, and has adopted 17 different project protocols. The Reserve's role in the carbon market is to ensure that carbon offsets comply with the required quality standards, to provide market confidence, define protocols and processes for offset development and trading, and serve as the platform for offset transactions and retirements.

To promote GHG emission reductions from grassland conservation, the Climate Action Reserve developed the Grassland Project Protocol (GPP; currently in Version 2.0). The protocol provides a standardized approach for quantifying, monitoring, and verifying the greenhouse gas reductions from the avoided conversion of grassland to cropland. The project consists of the establishment of a conservation easement that prevents the breaking of land that has been in continuous grassland cover for at least ten years.

Eligible lands are located in the lower 48 United States;[3] are owned privately or by non-federal public entities; have been grassland for at least 10 years; have no more than 10% tree canopy cover in a per acre basis; are located in counties where the cropland rent is least 40% higher than the pasture rental rate; and contain soils suitable for crop cultivation. The GPP details how eligibility is to be assessed through standardized approaches.

[1] Intergovernmental Panel on Climate Change. *Climate Change 2014 Synthesis Report: Summary for Policymakers.* Geneva : s.n., 2014.

[2] Climate Action Reserve. Grassland Project Protocol v2.0. available at: http://www.climateactionreserve.org/how/protocols/grassland/

[3] A separate Canada Grassland Project Protocol is expected to be adopted by the Reserve in October 2019. This protocol, largely similar to the US GPP v2.0, will allow for crediting of avoided grassland conversion projects in Canada.

To streamline project development efforts and costs, the Reserve adopted an aggregation approach through "cooperatives"[4] that manage groups of more than two projects for joint monitoring, reporting, and verification. Site visits during verification are not required, but at least one is recommended to remove an added 5% buffer pool contribution. In addition, the Reserve makes available the Excel-based GrassTool to support emission reduction quantification, and the web-based GrassMap to facilitate the evaluation of project eligibility.

To date, there are five projects registered (i.e., offsets have been issued) and five projects listed (accepted into the registry based on initial documentation, but not yet verified) in the states of Oregon, Montana, and Colorado. In total, the Climate Action Reserve has issued 62,375 offsets to grassland projects, supporting the conservation of 39,814 grassland acres.

For further information on the Reserve's Grassland Project Protocol go to http://www.climateactionreserve.org/how/protocols/grassland/ or contact the Reserve Policy Team at policy@climateactionreserve.org.

LEVERAGING CARBON MARKETS TO FUND RANGELAND EASEMENT PURCHASES

Julius Pasay, The Climate Trust

New carbon market protocols for the avoided conversion of grasslands are available to grassland owners and holders of conservation easements. Avoided conversion of grassland carbon projects generate soil carbon credits that can be sold on the voluntary carbon market. The Climate Trust, through Climate Trust Capital Fund I, piloted three up-front carbon project investments to help finance the purchase of conservation easements on several grasslands in Oregon. The Climate Trust's up-front investment model is scalable and can be used to help finance conservation easements on ranches and grasslands throughout the country.

SITE WIND RIGHT

Nathan Cummins, The Nature Conservancy

Other Authors: Michael Fuhr, TNC; Jessica Wilkinson, TNC

The Nature Conservancy supports the rapid expansion of renewable energy while protecting wildlife and natural habitats. This session summarized the data and assumptions included in The Conservancy's Site Wind Right assessment, as well as how we intend the results to be used. The Site Wind Right map was created to identify areas where wind development is unlikely to encounter significant wildlife-related conflict, project delays, and cost overruns. The map was designed to serve as an important source of information to inform screening early in the project siting process. It can be used to support application of the U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines, specifically Tier 1 and Tier 2 evaluations. By combining the Site Wind Right map with other land suitability factors, we demonstrate that over 1,000 GW of wind energy may be developed in the central U.S. exclusively in areas of low conservation impact. The results of this analysis indicate that we can accelerate a clean, low-impact energy future—one that advances energy, climate, and conservation goals.

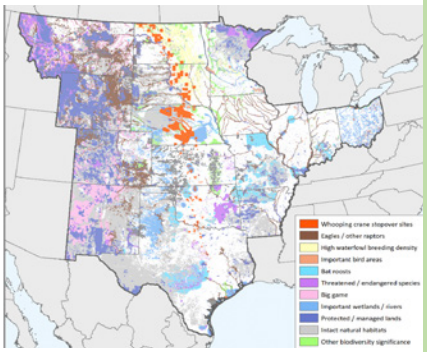

Figure 1. Site Wind Right map.

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[4] In the context of the GPP, a "cooperative" is not a legal entity.

13. GRASSLANDS POLICY AND EASEMENTS

HOW GRASSLANDS FARED IN THE 2018 FARM BILL

Aviva Glaser, National Wildlife Federation

The Farm Bill is a massive piece of legislation covering all aspects of federal farm, food, and conservation policy. Passed every five years, the Farm bill is the largest source of funding for conservation on private lands. With 60% of U.S. land privately owned and around 50% of U.S. land currently managed as cropland, pastureland, and rangeland, the Farm Bill is critically important for wildlife and conservation. Since 2009, USDA has helped over 500,000 farmers, ranchers and landowners to protect land and water on over 400 million acres nationwide through Farm Bill conservation programs.

Farm Bill conservation programs provide financial incentives and technical assistance for farmers, ranchers, and forest owners to adopt more sustainable practices. Practices includes protecting and restoring native grasslands, adopting advanced grazing management practices, and creating buffer or prairie strips. Participation in Farm Bill conservation programs is voluntary. These programs are very popular; most are oversubscribed with large backlogs of farmers and ranchers waiting to enroll.

The 2018 Farm Bill was signed into law December 20, 2018 and included a number of conservation victories and important outcomes for grasslands – as well as more work that needs to be done. Below are six key outcomes for grassland conservation in the bill:

1. No cuts to conservation funding. The last Farm Bill (the 2014 Farm Bill) unfortunately included significant cuts to conservation programs. During the 2018 Farm Bill negotiations, it looked like this bill might also include cuts to conservation funding; the House had proposed a $795 million cut. Fortunately, the final 2018 Farm Bill did not have any cuts to conservation funding and provides $60 billion in conservation funding over 10 years.

2. Dedicated wildlife funding. Under the 2014 Farm Bill, the Environmental Quality Incentives Program (EQIP) was given a small carveout for wildlife; at least 5% of EQIP funds had to go towards wildlife habitat practices. Much of this funding goes towards the popular and successful Working Lands for Wildlife Program Compared to previous Farm Bills, however, this was a decrease in funding dedicated for wildlife habitat. A major goal from the wildlife community in the 2018 Farm Bill was to double the amount of dedicated wildlife funding to at least 10% of EQIP funds. This was a victory for conservation—the final farm bill doubled the minimum amount of funding for wildlife from at least 5% of EQIP to at least 10%. As a result, between 2018-2023, there will be an additional $600 + million over and above current wildlife funding levels that will go towards helping farmers and ranchers create wildlife habitat on working lands.

3. Sodsaver. Sodsaver is a provision that helps to protect remaining native prairies from conversion to cropland by reducing subsidies for producers who convert native grassland to cropland. Under this provision, farmers can still choose to convert their land, but sodsaver limits the farm subsidies that producers can receive on newly converted land for a few years after conversion. The 2014 Farm Bill included a limited sodsaver provision that applies to six states only: IA, ND, SD, MN, MT, NE It was a good start, but grassland conversion is not limited only to those states. In order to truly be effective, it must be made nationwide. Additionally, the provision included a loophole that weakened sodsaver. A major conservation goal for

the 2018 Farm Bill was to expand sodsaver to make it nationwide and strengthen sodsaver by closing the loophole. The final result was only a partial victory - sodsaver was strengthened but it was not expanded nationwide. Looking towards the 2023 Farm Bill, this is likely to be an important grassland conservation goal.

4. Native vegetation standard. Many people do not realize that under certain Farm Bill conservation programs, USDA actually pays farmers to plant non-native species. Common non-natives used in farm bill conservation programs include tall fescue, Kentucky bluegrass, Bermuda grass, and smooth bromegrass. A number of wildlife groups have proposed that USDA adopt a native vegetation policy to prioritize the use of ecologically-appropriate and diverse stands of native plants in USDA conservation programs wherever possible. The standard would be voluntary, allowing for situations in which non-invasive introduced vegetation are the best way to address resource concerns. Unfortunately, the 2018 Farm Bill does not include language directing USDA to create a native vegetation management standard. The manager's report does, however, include strong language recognizing the benefits of using native plants.

5. New incentives for grasslands/grazing. A bright point in the 2018 Farm Bill for grasslands was the inclusion of increased opportunities within working lands programs for grazing management practices, as well as improved access to conservation planning for rangeland. The bill also included new incentives for grazing practices that promote drought resilience, wildfire management, and wildlife habitat and greater flexibility for easements and partnerships, including for grasslands.

6. Conservation Reserve Program (CRP). CRP is one of the largest and most important conservation programs, with considerable benefits for soil, water, and wildlife. The CRP program enables farmers and ranchers to take marginal, environmentally sensitive cropland out of production and plant it with environmentally-beneficial plant mixes. The last two Farm Bills included large cuts to CRP –which has led to a major loss of grass and habitat on the landscape. The 2018 Farm Bill actually increased the acreage cap for CRP. However, that increased cap came at the expense of reduced rental rates, which may lead to lower interest in the program. Since the passage of the 2018 Farm Bill, we have unfortunately begun seeing reduced enrollment in the program. With millions of more acres set to expire, this will be an important area to focus on for implementation and looking towards the next Farm Bill.

Despite being written and passed during a partisan and difficult Congressional climate, the 2018 Farm Bill overall had significant wins for grasslands and conservation. But the work isn't done. There is a still a need for engagement on farm bill implementation. That includes weighing in on rulemaking, participating in State Technical Committees, and continuing to push USDA to implement conservation programs in a way that maximizes the benefits for grasslands and wildlife. The next Farm Bill will be in 2023, which means that the grassland conservation community should begin thinking about priorities for the next Farm Bill.

STATE AND LOCAL STRATEGIES: SOIL HEALTH POLICY FROM THE GROUND UP

Duane Hovorka, Izaak Walton League of America

State and local policymakers in the United States are gaining a growing appreciation of the public benefits of healthy soils, including improved water quality, reduced soil erosion, reduced runoff, increased resilience in farming systems, reduced need for chemical nutrients and pesticides, and significant amounts of carbon stored in the soil. They have responded with a rapid increase in the number and diversity of soil health policy initiatives at the state and local level.

Those initiatives have taken a variety of forms. At the state level, examples include a comprehensive multi-agency initiative launched by former California Governor Jerry Brown in 2015, the New York Soil

Health Roadmap developed through a partnership led by Cornell University, and state task forces created by legislatures in Hawaii and Nebraska. State legislatures have created soil health programs in states like Maryland and New Mexico. State agencies have developed innovative approaches such as state funding for a $5 per acre discount on federal crop insurance premiums for farmers who plant cover crops, pioneered in Iowa.

At the local level, soil and water conservation districts have taken the lead in outreach to farmers, ranchers, and non-operating farmland owners, holding soil health workshops, farm tours and training sessions, and providing technical assistance to help landowners plan for and adopt soil health practices. The Champaign County Soil and Water Conservation District in Illinois created *Saving Tomorrow's Agriculture Resources* (STAR), a free tool to help farmers and landowners assess their nutrient and soil loss practices at a field level, and the STAR tool is being adopted by other Illinois districts and adapted in other states. The South Jersey Resource Conservation & Development Council in New Jersey acquired a roller-crimper which it loans to farmers interested in testing a non-chemical method of terminating cover crops.

Given the many public benefits that result from improved soil health, state and local policy-makers are testing a variety of policy options to drive soil health improvement on private farms and ranches and on public land. In the future, it will be important to track and evaluate the success of these diverse policy tools in achieving soil health objectives. The Izaak Walton League of America's report, *State & Local Soil Health Strategies: Building Soil Health Policy from the Ground Up,* summarizes two dozen initiatives from around the country, with links to source material, and can be downloaded at www.iwla.org/agriculture.

INITIAL REVIEW OF WILDLIFE-RELATED REGIONAL CONSERVATION PARTNERSHIP PROJECTS

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Background

The Regional Conservation Partnership Program (RCPP) offered by the US Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) was enacted as a part of the 2014 Farm Bill. This innovative enterprise of USDA offers a great deal of opportunity for regionally led conservation. RCPP is designed to provide financial and technical assistance to conservation partnerships.

Figure 1. What is the Regional Conservation Partnership Program?

This survey and the underlying purposes were first reported to the Agriculture Conservation Committee of AFWA through its Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP) Working Group. A summary was provided to the full Agriculture Conservation Committee, which resulted in the creation of a new RCPP Working Group (OPJV 2018).

RCPP is a large change for USDA and partners, and it began with a short timeline required by Congress that resulted in the agency and its partners/applicants to learn and invent processes and conservation approaches on the fly. This compressed schedule both compelled innovation and it challenged bureaucratic methods. In the end, there was a lot of confusion and delays, but a lot of positive results. It is important to understand that Congress continues to increase financial assistance to producers while it consistently cuts funding for USDA staff. One can infer from this consistent trend that an important intent of RCPP is to build capacity to deliver technical assistance to producers and other program participants outside of USDA.

To begin to better understand the impacts and impediments to the roll-out of RCPP, we conducted a review of the projects using public information made available by NRCS (USDA 2019). The review revealed that approximately 350 projects have been awarded funding for a total of about $1 billion in federal support that is leveraged against (this is not a true match) even more local support funding and in-kind services. By reading through the provided narratives, initially 72 projects were deemed to be focused broadly enough on wildlife conservation to include. After extensive research of the managing and partner organizations, we were able to contact an appropriate partnership leader for most of the identified wildlife-related projects. We then conducted a brief survey of those managers to begin to determine basic metrics related to progress, function, efficiency, and satisfaction associated with the projects.

This project was undertaken to assess the initial deployment of RCPP and to develop a network of RCPP collaborators. We hope to use the information we have assembled to further refine our knowledge-base through various participatory processes. We also plan to build on the network of collaborators to aid current and future wildlife-related RCPP projects. We hope that these efforts will result in quicker project establishment, the development of standardized efficient processes, and greater conservation outputs across the RCPP.

Program Status

As was mentioned above, the RCPP program has awarded over $1 billion to date to over 350 partnerships (USDA 2019a). The following map (figure 2) is a depiction of the current concentration of RCPPs by state (USDA 2018). Considering the complexity of the program and the brief time that USDA was given for implementation, it appears that there has been great progress. Changes made through the 2018 Farm Bill promise to provide more innovations and considerably more funding.

Changes to RCPP in the 2018 Farm Bill

In the 2018 Farm Bill (AIA 2018), Congress enacted several changes intended to improve the program. NRCS is now charged with carrying out those changes by creating a stand-alone RCPP Program, incorporating the newly-enacted mandates and promulgating updated rules.

Table 1. Limited description of congressional RCPP changes in 2018 Farm Bill.

2014 Farm Bill	2018 Farm Bill
$100 Million per year (initial authorization)	$300 Million per year
Not a Stand-alone Program: uses NRCS Programs/ Systems: EQIP, CSP, ACEP, etc.	Stand-alone Program and now draws elements from NRCS Programs (on left), CRP, PL83-566 Watershed Program
Funding always side-by-side, Partner to USDA	New possible alternative "financial arrangements"
3 funding pools: National, State & Critical Conservation Areas	2 Funding Pools: State and Critical Conservation Areas

The Survey

Our survey of 72 wildlife-related RCPP projects resulted in 51 responses. The survey questions are provided in Appendix 1, but some of our results and their explanation are presented herein. We asked respondents about the stage of development of their RCPP project to begin to assess the efficacy of the

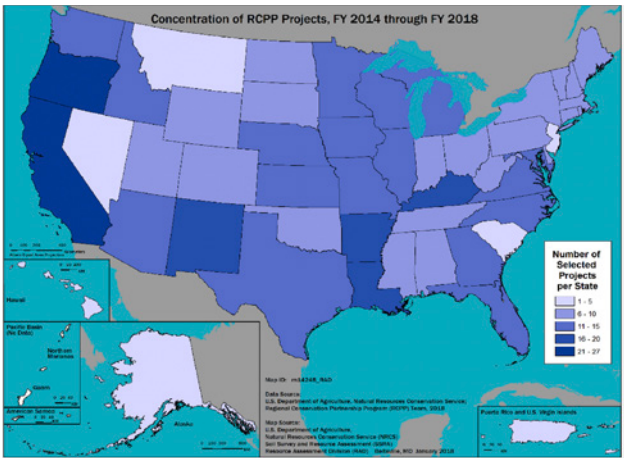

Figure 2. Concentration of RCPP Projects, FY 2014 through FY 2018.

first four years of program deployment. Once projects are accepted by NRCS, several stages of development follow: negotiation and agreement development between lead partners and NRCS, local process development with NRCS, project deployment with private landowners, completion of deployment, end of program. From these data we were able to detect that there have been some challenges with deployment, but that most projects are in the deployment phase.

We asked respondents to list the partners involved in each RCPP project. Figure 3 is depiction of the frequency various partners were listed. It helps to demonstrate the breadth and frequency of partnerships among the various wildlife-related RCPP projects.

We wanted to determine how respondents felt about general training that was provided by NRCS related to their experience with RCPP. We did not try to assess details about which aspects of training may have been provided, but we think the data express that more training would have been helpful. Training is a factor that deserves much more study as it plays an important role in the pace of deployment, efficacy of delivery and probably the conservation outcomes that can be expected to be achieved. This element likely also provides some insight about satisfaction with the process. The data indicate that there was plenty of room for improvement in training.

Figure 3. Relative frequency (indicated by font size) wildlife-related RCPP partners were mentioned by respondents.

Next Steps

As mentioned earlier, an Ad Hoc RCPP Working Group of the Agriculture Conservation Committee of the AFWA is now charged with leading oversight and development of RCPP related matters. Through this Working Group we will continue to interact with wildlife-related RCPP project managers to learn more about how various aspects of the program are working. We are also charged with providing guidance through AFWA that can serve as feedback to Congress and USDA to help improve the program and its administration. Finally, we expect that our efforts will help to accelerate the wildlife benefits that may result from RCPP projects.

For Future RCPP Applicants

Between the time of presentation and the development of this manuscript, USDA has announced an RCPP enrollment period that extends through December 3, 2019 (USDA 2019b). Some things to remember when developing a project:

- Proposals must be creative and solve local problems with local solutions.
- Learn how NRCS does business (i.e. Field Office Technical Guide, Practice Standards, Practice Cost Lists, local offices, area offices, state offices, etc.
- Collaborate early and often with local NRCS and state leadership to be sure your proposal is strong and that it includes proven strategies as much as possible.
- Identify how you will provide technical assistance outside of NRCS.
- Include strong training and evaluation components from NRCS and throughout your delivery team.
- Don't overcomplicate things. Start small and build more as partnership grows.
- Become involved with the RCPP Working Group.

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CONSERVATION EASEMENT ALLOCATIONS TO ADDRESS LOCALIZED SPILLOVERS IN GRASSLAND CONVERSION: A MODEL WITH EMPIRICAL EVIDENCE USING REMOTELY-SENSED DATA

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Introduction and Motivation

Much of America's grasslands are privately owned and in grass-based beef production. One of the most prominent policies that the United States federal government has had in place to keep these lands under grass has been the property easement contract. This program is facilitated by the U.S. Fish & Wildlife Service acting as administrator for duck stamp and similar funds obtained to protect these lands for hunting and other purposes. Property ownership bundles a large number of rights and obligations. The idea behind grassland easement contracts is to separate the right to use the land for purposes other than grass cover from all other rights and obligations. The property owner who enters a grassland easement commits the land to that purpose in perpetuity in return for a one-time capital payment. The contract is binding on all subsequent land owners. This payment is intended to compensate the owner for foregone options to obtain any future rewards from conversion to other uses.

The cost of such easement payments has increased dramatically since about 2007. At about that time agricultural land prices in the Midwest and Great Plains rose dramatically. Table 1 shows survey reported land prices for land under grass over the 1994-2019 period in three among the five South Dakota agricultural districts that are east of the Missouri River. This is an area favored by migratory birds because wetlands and grasslands in the area provide abundant nesting and feeding opportunities. Reported too is the national average corn prices over that period. The cost to purchase easement rights is in rough proportion to the land price so budgets to make easement purchases have been stressed over the past decade. In response, the U.S. Fish & Wildlife Service (USFWS) has sought to focus on possibilities for more effectively leveraging these funds. One approach proposed has been to shift targeting away from lands that maximize reference ecological benefits under grass, and toward lands that maximize reference ecological benefits under grass per dollar spent on easements (Walker et al., 2013). To illustrate, suppose that land tract A provided 500 reference benefit points per acre at a total cost of $500 per acre while tract B provided 300 reference benefit points per acre at a total cost of $200 per acre. A benefit approach would prioritize tract A while a benefit per dollar approach would prioritize tract B.

One problem with both the benefit targeting and the benefit per dollar targeting approaches is that

no explicit consideration is given to whether the land would be converted at all. In other words, if the conversion probability is zero then expenditures on protection do not act to maximize benefits saved. Nor do they act to maximize benefits saved per dollar spent. This is the additionality problem and it is a major issue for environmental program impact assessment. In regard to grassland easements, the additionality issue has been considered by Claassen et al. (2017). They have found that, having sought to control for benefits that should not count because they were not additional, grassland easements have had a modest effect in protecting grasslands from conversion. They also found that potential may exist to further increase program effectiveness.

Model Intent

Claassen et al. (2017), and indeed the vast majority of work that we are aware of on evaluation of programs to protect environmental benefits, treated the tracts under scrutiny as stand alone in the sense that assessment of the program's effectiveness does not consider how what is happening in the neighborhood affects the decision to convert grassland. Stephens et al. (2008), and for the Northern Great Plains Prairie Pothole Region study area that is also of interest to us, found that cropping on neighboring lands is a factor in conversion choices. However, their work did not address how easements can affect local conversion incentives. For the Prairie Pothole Region of Western Canada, Lawley and Yang (2015) study how the placement of easements affects subsequent easement location choices. They find evidence, having sought to control for other effects, that easements do beget easements. They conclude that this may be because conservation agencies seek to place easements together. Or, they suggest, it may be because the placement of easements better enables landowners in the area to learn about and become less concerned with this land use choice. One interpretation of this finding is that the act of placing an easement may reduce the cost of placing easements in the area at a later time, i.e., there are cost-side spillovers that are beneficial to program goals.

Our paper also addresses localized spillover effects for grassland conversion and how easements may affect such spillovers. However we focus on spillovers effects on the ultimate concern, namely grass to crop conversion. Our interest is understanding whether there are benefit-side spillovers and, if so, what is the nature of such spillovers. The idea is quite simple. No farmland, whether under grass or annual crops, is farmed in isolation. Within a farm, growers who have acquired knowledge about and equipment for grass production may seek to leverage that knowledge over more acres. Likewise, growers of annual crops may seek to leverage their assets over more acres. Land that could be used for grass-based beef production but is marginal for cropping is likely to be grazed by a farmer emphasizing beef production but cropped by a farmer emphasizing crop production.

A similar logic extends beyond the individual farm, where the growth of support services to be leveraged plays the role of individual expertise to be leveraged. If crop production develops a presence in a locality then support services in the form of machinery and agri-merchant dealerships, tiling and drainage services, crop insurance agents, and hauling services may enter, thus lowering the costs of cropping to others who are contemplating conversion from grassland to crop production. In this light there emerges a potential role for grassland easement contracts to place a brake on these dynamics. Our work uses historic land use and easement data to shed light on whether grassland easements have performed this role.

Model Design, Implementation and Preliminary Findings

Our model is comprised of three parts. The third part (Part 3) provides our policy findings while the other two are needed to address concerns that certain variables that may be important in the conversion decision are themselves in part determined by the conversion decision. Part 3 seeks to clarify any the role that easement land has in determining nearby conversion rates to cropland from permanent grassland. The land scrutinized has been tracked by satellite over 30 years so that it can be fairly labeled

as permanent grassland at the outset of our analysis (Arora and Wolter, 2018). The conversion choice time series scrutinized was 1997-2016 for North Dakota and 2006-2016 for South Dakota. The earlier dates were determined by data made available under the USDA NASS Cropland Data Layer project.

The first part (Part 1) seeks to explain eased land choices by using benefits (duck pair density), costs (land value) and available funding (duck stamp dollars). Easement location and duck pair density data were kindly provided by USFWS. In Part 2, output from Part 1 model was combined with information on land quality (slope and capability class, obtained from the USDA SSURGO dataset), distance to markets and grassland profitability to model an area's non-eased grassland intensity. Output from Part 1 and Part 2 were then combined with other data in our Part 3 grassland survival duration model. Although our findings are preliminary and we are in the process of improving the model, our preliminary analysis suggests that both the proportion of non-eased grass and the proportion of eased grass in an area depress the rate of grassland conversion in the area. Thus, there is some evidence that grassland easements have spillover effects that further grassland preservation goals.

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Table 1. Pastureland prices, all grass, for three East River South Dakota districts, together with national corn price.

Year	Southeast	East Central	Central	Corn price[a]
1994	$319	$283	$190	$2.26
1999	$405	$386	$255	$1.82
2004	$684	$764	$456	$2.06
2009	$1,258	$1,458	$898	$3.55
2014	$2,698	$2,861	$1,828	$3.70
2019	$2,518	$3,159	$1,863	$3.61[b]

Notes: Pastureland price data are from Appendix Table 2 (all grass) in Davis and Dunaway (2019).
a National average price for marketing year, from USDA Quikstats.
b 2018 marketing year.

GRASSLAND EASEMENT ACQUISITION: CONVERSION HAZARD RATE, ADDITIONALITY, AND SPATIAL SPILLOVER

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Grassland provides critical ecosystem services and human impacts have put many grassland ecosystems at risk (White et al. 2000). Grassland protection has attracted much attention as numerous conservation programs have been developed and significant investments have been directed at grassland conservation (NFWF 2016). Easement contracts can be a means of precisely attenuating property rights through consensual and fair exchange. In fact, grassland easements are viewed by the U.S. Fish and Wildlife Service (USFWS) as "the most cost-effective and socially acceptable means to ensure protection of important habitats" (USFWS 2011, p. 10). However, high crop returns over the past decade have imposed substantial financial pressures on easement acquisition. Walker et al. (2013) show that the average easement payment rate in the U.S. Prairie Pothole Region (PPR) almost quadrupled between 1998 and 2012, from $195/acre to $778/acre. Therefore, easement evaluation and acquisition have attracted increasing attention.

Since easements prevent grassland conversions in uncertain future states of nature, reliably accounting for future possible conversion incentives as well as the dynamic and stochastic nature of landowners' conversion decisions is key to understand the benefits and costs of alternative approaches. However, the current approach in easement acquisition practice typically specifies the easement value as a fraction of market value of land (Walker et al. 2013). It does not consider the uncertainty of land-use returns and the possible land-use outcomes resulting from this uncertainty. Furthermore, it does not explicitly account for the spatial spillover effect of land-use change, where the spatial spillover effect indicates that converting one tract of grassland may increase the conversion probability for neighboring grassland tracts, and that placing a grassland tract under easement may reduce a neighboring grassland tract's conversion probability. The spatial spillover effect can be an important factor that influences grassland conversion (Costello and Polasky 2004; Arora et al. 2019).

This paper is an attempt to fill the gaps described above by developing an internally consistent conceptual framework that integrates conversion risk, acquisition costs, environmental benefits, and spatial spillover effect into the decision rule for easement acquisition. Our intent is to a) provide easement managers with a more structured and data-driven framework to assist in acquisition decisions; b) highlight the importance of acquisition targeting strategies in determining the environmental benefits generated by the easement program; and c) explore heuristic land selection algorithms that are straightforward to implement for easement managers. These strategies are: 1) one that views environmental benefits from eased grassland as benefits secured by easement acquisition and does not consider spatial spillover effect, termed "basic targeting"; 2) one that considers conversion hazard rate when quantify secured environmental benefits but ignores the spatial spillover effect, termed "additionality targeting"; and 3) one that considers both conversion hazard rate and the spatial spillover effect, termed "additionality with spatial spillover targeting".

In addition to these targeting strategies, we also explore the performance of three heuristic algorithms to solve the easement manager's stochastic dynamic programming problem. These three heuristic algorithms are: 1) one that selects land tract with the largest targeting environmental benefit available in the decision period without considering the tract's conversion probability, termed "naïve myopic algorithm"; 2) one that selects land tract with the largest product of targeting environmental benefit

and conversion probability in the decision period, termed "informed myopic algorithm"; and 3) one that is similar to aforementioned 2) but with spatial spillover incorporated in the conversion probability, termed "spatially informed myopic algorithm". A common feature of these three heuristic algorithms is that under them the easement manager only seeks to maximize the current-period environmental benefits without considering the dynamic nature of the optimization problem.

We first develop a theoretical framework on a representative easement manager's acquisition problem by using a stochastic dynamic programming approach. Because explicitly solving the stochastic dynamic programming problem is quite challenging, we employ a simple example in which only four tracts of grassland are considered to illustrate the difference in acquisition outcomes between various acquisition targeting strategies.

Assuming that at the very beginning of period one there are four grassland tracts, namely A, B, C, and D, available to be eased. The geographical configuration of these four tracts are shown in Figure 1. Specifically, tracts A, B, and C are neighbors, with tract B located between tracts A and C but closer to tract A than to tract C. However, tract D is not a neighbor of any tract. Spatial spillover effect exists only among the neighbors (i.e., tracts A, B, and C). As a result, tract D does not generate or receive any spatial spillover effect. For illustration purposes, we consider some specific values for the environmental benefits and conversion probability of each tract under various targeting scenarios

We find that in the optimal solution "additionality with spatial spillover targeting" outperforms "additionality targeting", which outperforms "basic targeting" in terms of securing environmental benefits. However, this order may not hold under heuristic algorithms. Particularly, under "naïve myopic algorithm" and "informed myopic algorithm" the three targeting strategies generate the same additionality of environmental benefits. Under "spatially informed myopic algorithm", however, "basic targeting" outperforms the other two targeting strategies. This result highlights the importance the selection of targeting strategy and heuristic algorithm. For future work, we will apply this to the real world situation of grassland easement targeting in the U.S. PPR.

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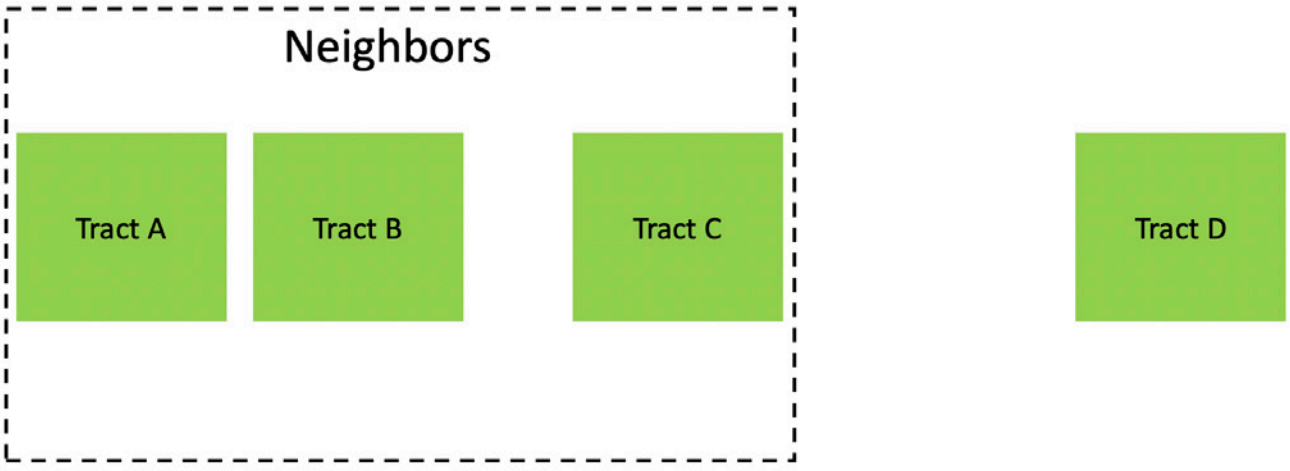

Figure 1. Location of grassland tracts in the four-tract example.

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EXPLORING CONSERVATION AND AGRICULTURAL POLICIES THAT AFFECT IMPLEMENTATION OF TRANSCONTINENTAL GRASSLAND CONSERVATION

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North American grasslands are among the most threatened ecosystems in the world. Their soils and climate make them highly productive for agriculture, resulting in extensive loss of native grasslands and grassland-dependent wildlife due to land conversion. Fortunately, people are coming together from across the continent to address this urgent and challenging issue. Creating a coordinated approach to transcontinental grassland conservation will require an understanding of conservation and agricultural policies in Canada, the United States, and Mexico. In our presentation, we explored existing public policies in each country and how they influence opportunities and challenges associated with grassland conservation. How do land and water use policies affect our ability to conserve native grasslands in North America? We need this understanding to develop a robust approach to halting grassland loss.

In discussing conservation and agricultural policies that affect implementation of transcontinental grassland conservation with our conservation partners in all three countries, there were many challenges identified. What also emerged were some common themes pointing to solutions and opportunities. These include the need to think big and plan broadly; a focus on improving policies and programs to promote and incentivize conservation and sustainable agricultural practices; an emphasis on building bridges between sectors and enhancing opportunities to collaborate; and engaging people at the local, grassroots level to increase awareness and action related to the conservation issues most relevant to their communities.

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POSTER PRESENTATIONS

IMPACTS OF THE RENEWABLE FUEL STANDARD ON AMERICA'S GRASSLANDS AND WATERS

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The U.S. Renewable Fuel Standard (RFS) has been implicated as an agent of influence in agricultural commodity markets and as a driver of land use and land management changes. However, direct attribution of these effects to the RFS has remained elusive and uncertain, a shortcoming that has hindered policy evaluation and potential reform. We analyzed the effects of the RFS on corn, soy, and wheat prices and integrated these results with (i) an econometric model of land use response, (ii) spatially explicit observations of land use change, and (iii) additional biophysical and empirical models of agro-ecological processes to quantify the land and water impacts of RFS policy implementation.

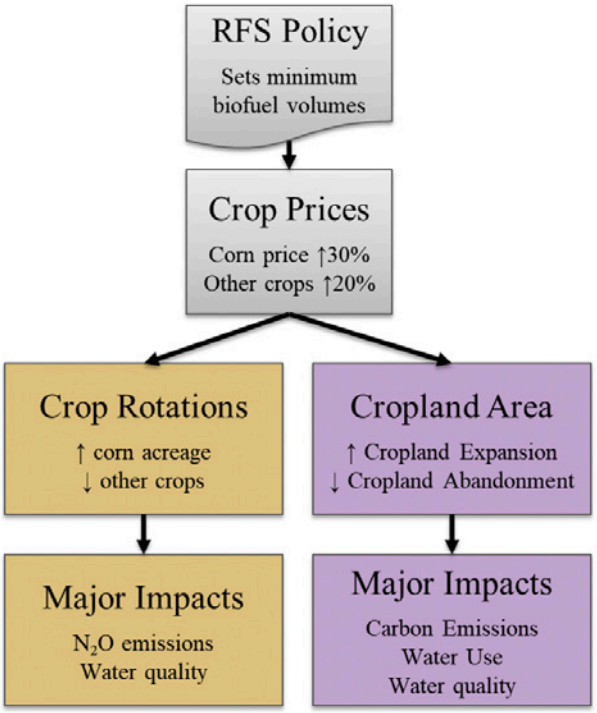

Figure 1: Overview of an empirical framework for estimating the effects of the Renewable Fuel Standard.

We independently modeled the effects of the policy via two pathways—crop intensification, or the preferential planting of corn instead of other crops, and cropland extensification, or the conversion of grasslands and other natural lands to cropland. Our preliminary results show that in the 8 years following passage of the RFS in 2007, the policy bolstered the amount of corn planted on existing cropland each year by an estimated 6.9 million acres and stimulated an increase in total cropland area of approximately 5 million acres. These landscape changes likely resulted in more than a million tons of additional nitrogen application as well as estimated carbon emissions of approximately 40 Tg CO_2e yr^{-1}.

This work provides an observation-based, spatially explicit accounting of key field-level impacts of the RFS on U.S. grassland conversion and associated environmental outcomes. The approach provides a blueprint for the integration of comprehensive land change data with causal economic models and demonstrates a method for measuring environmental outcomes across an entire agricultural industry, from the policymaking process through to implementation on the landscape. These reported data and results should be considered preliminary and are from an upcoming publication. For more information and most recent research results, visit www.gibbs-lab.com/us/

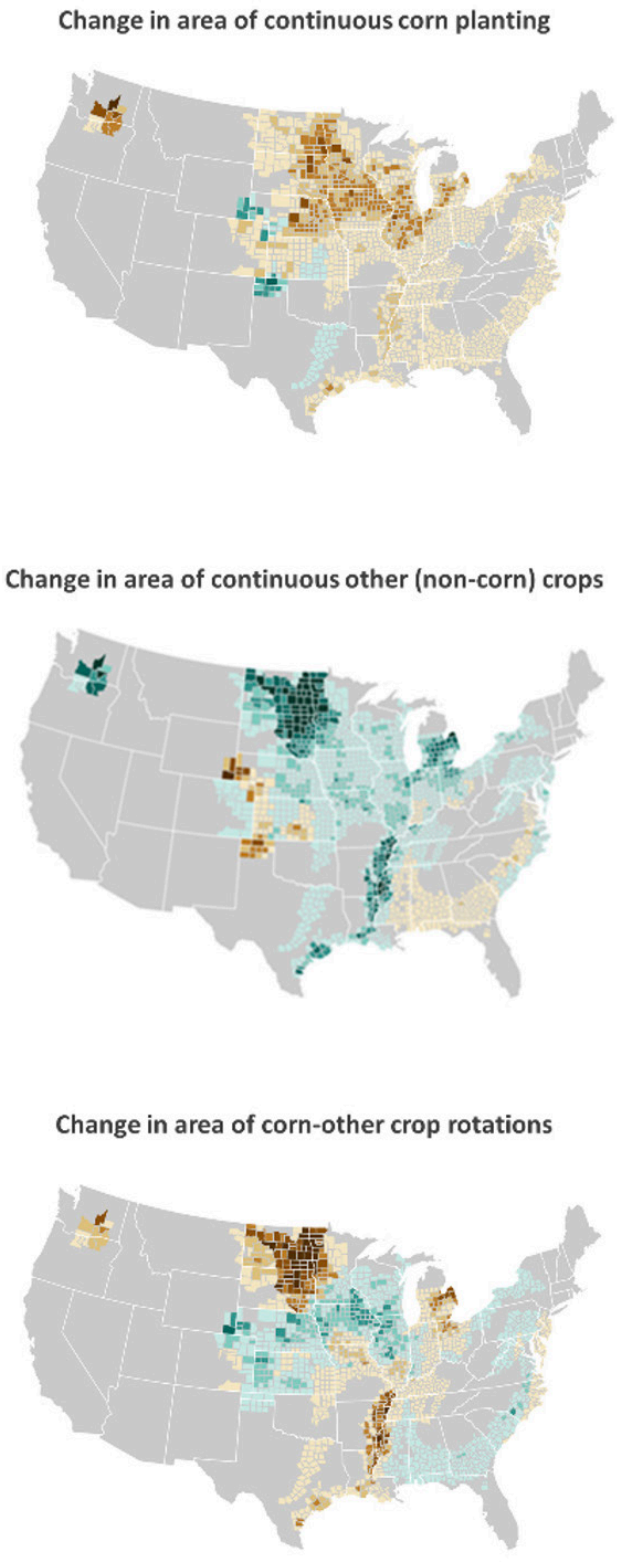

Figure 2: Impact of the RFS on crop rotations.

GRASS TO GRAIN: PROBABILISTIC MODELING OF AGRICULTURAL CONVERSION IN THE NORTH AMERICAN GREAT PLAINS

Sarah K. Olimb, World Wildlife Fund

Other Authors: Barry Robinson, Canadian Wildlife Service, Environment and Climate Change Canada

Conversion of temperate grasslands in the North American Great Plains has long been identified as a threat to native species and systems. Avoiding conversion, particularly to agricultural cover, has been modeled to show benefits for preserving species diversity and connectivity and maintaining ecosystem services provided by grasslands such as avoiding nutrient and sediment runoff. To identify areas of likely conversion, we employed a probabilistic ecoregion-wide model using soil, topography, and climate variables to simulate future conversion. Our results indicated that roughly 60% of the ecoregion is at moderate or higher risk of conversion or has previously been converted. These data can be used to direct grassland conservation efforts and as a metric to assess suitability of future crop expansion. Also, with added information on government subsidies, clean energy mandates, conservation incentives, and other economic data, our model can be used to assess the benefits and disadvantages of such programs and policies.

Manuscript: https://doi.org/10.1016/j.ecolind.2019.02.042

Research Highlights

- 60% of the Great Plains has been or is at high risk of agricultural conversion
- Climate is a greater predictor of agricultural conversion than soil or topography
- Transnational data/assessments are imperative for monitoring grassland conversion

Implications

Conserving remaining intact grasslands, rehabilitating previously converted lands to perennial habitat, and maintaining/establishing connectivity among grassland habitats are all important strategies for limiting habitat loss and maintaining species populations and vital ecosystem services provided by functioning ecosystems. This analysis, in conjunction with previous conversion data developed by Gage et al. (2016) among others, pinpoints the areas at greatest threat of future conversion. In addition, because this analysis uses geophysical attributes to measure likelihood of conversion (i.e. where the combination of soil, climate, and topographical properties are most suited to agricultural success), the data can be used as a metric to monitor the suitability of future conversion: the proportion of high-risk lands (those traditionally suited for row agriculture) that are plowed versus medium- and low-risk lands that, traditionally, were considered less suitable for any type of agricultural use. Combining these data with additional future

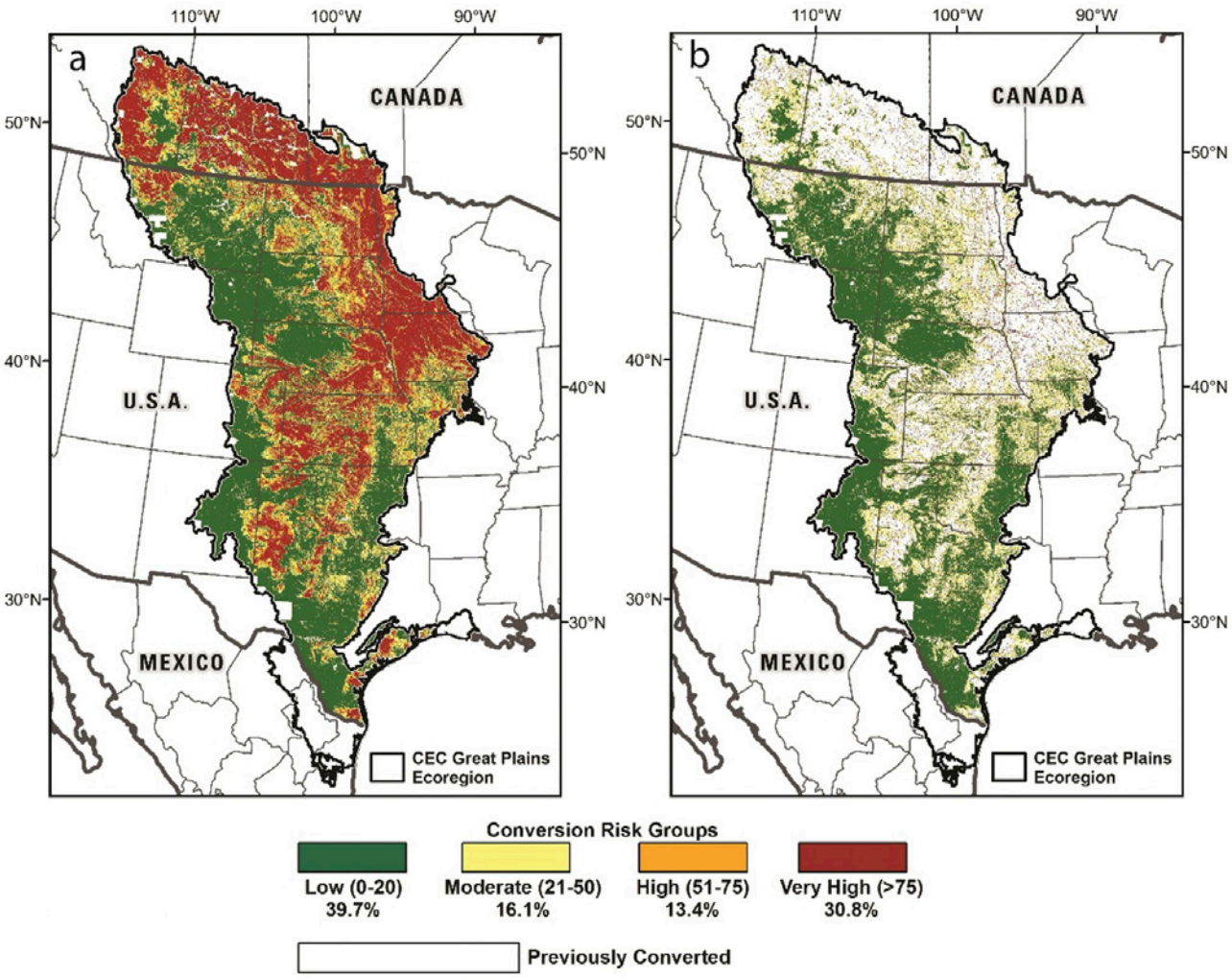

Fig. 1. a. Final conversion risk layer compiled from 1218 individual county/municipality level random forest models classified into conversion risk groups to highlight areas at low, moderate, high, and very high risk of agricultural conversion, including areas of previous conversion. Percentages indicate the proportion of the study area made up of each category. b. Same layer with areas of previous conversion from 2016 Plowprint data (46% of study area; Gage et al., 2016) shown in white.

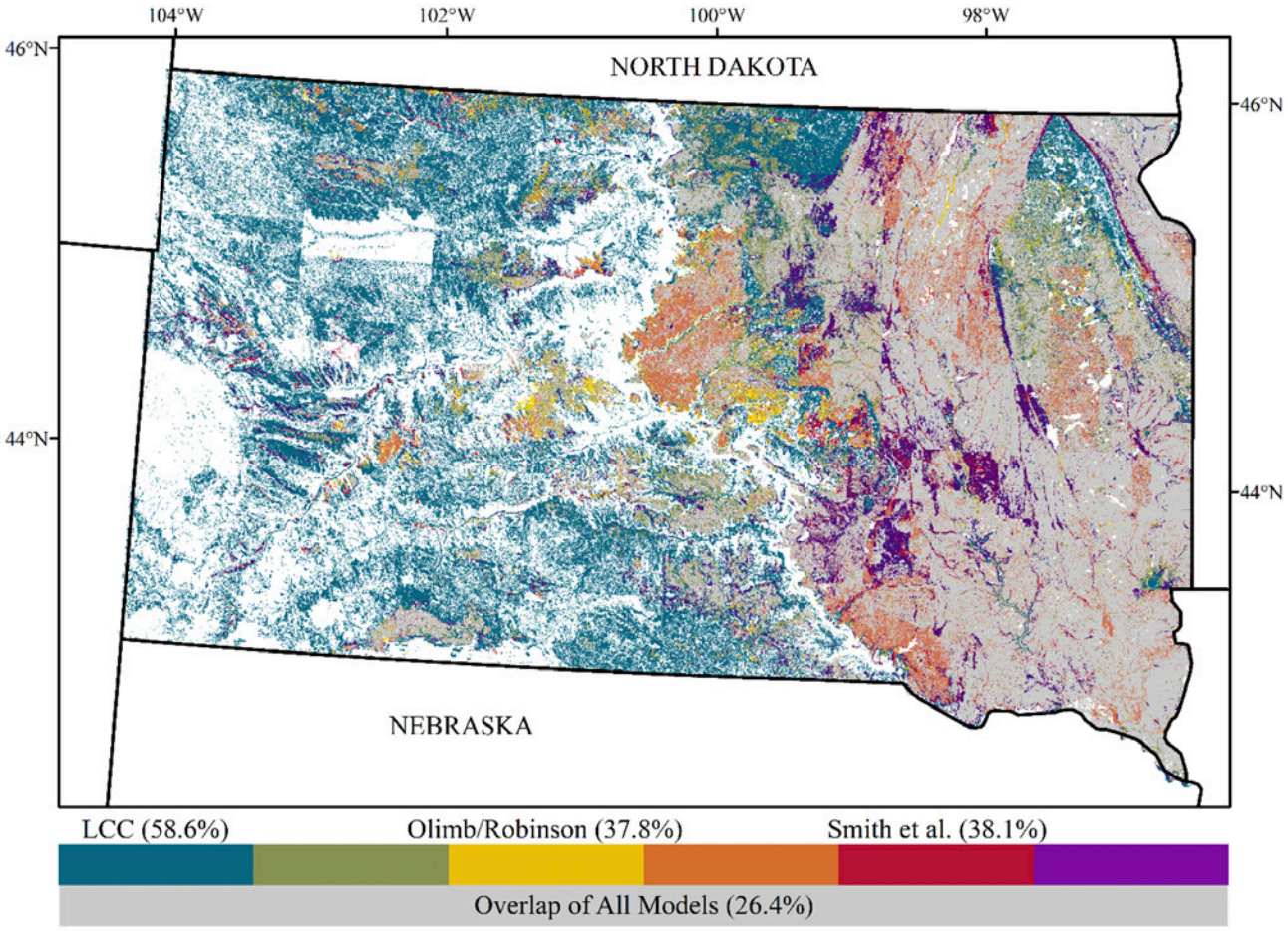

Fig. 2. Comparison of Olimb and Robinson conversion probability model to Smith et al. (2016) conversion probability model and the USDA Natural Resources Conservation Service (NRCS) Land Capability Classification (LCC) of cultivation capable lands in the state of South Dakota. The unique area of predicted/possible conversion for each model is shown as a primary color: Blue (LCC only), Yellow (Olimb/Robinson only), or Red (Smith et al., 2016 only). Blended colors (green, orange, purple) show overlap between two models and gray shows overlap between all three datasets. White areas are not predicted for conversion by any of the three models. The percentages show the proportion of the state predicted for agricultural conversion (e.g. the Olimb/Robinson model estimates that 37.8% of the total state area is at high risk of conversion through the combination of area unique to that model plus overlap with one or both other models). The overlap of all models estimates that 26.4% of the state is at high risk of conversion, including areas of previous conversion.

spatial crop conversion data along with information on government subsidies, biofuel expansion and clean energy mandates, conservation incentives, and other economic data could provide feedback on the success and/or disadvantage of continuing such programs or policies. As an example, if new incentives for ethanol production are correlated to a significant increase in new breakings for corn production, especially on sub-optimal cropland, this feedback could prompt revisions to the biofuel strategy.

Importantly, our study bridges the transnational US/Canada boundary, providing a relatively seamless model of conversion probability throughout the North American Great Plains.

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COOL-SEASON GRASS PERFORMANCE ON SALINE SOILS IN THE NORTHERN GREAT PLAINS

Wayne Markegard, Natural Resources Conservation Service

Other Authors: Wayne Duckwitz and Nancy Jensen, NRCS Bismarck Plant Materials Center; Ezra Aberle, North Dakota State University-Carrington Research Extension Center.

More than 10 million acres of soil in the Dakotas are considered saline. Producers and landowners who manage land impacted by saline soils are concerned with losses in production and continued expansion of acreage impacted by salinity. Large acreages of perennial grasses and forbs that once covered the prairie are now producing annual crops. Cropping systems shifted over the last 30-40 years from mostly fallow/small grain rotations to traditional diverse crop rotations with 5-7 crops, and most recently to rotations dominated primarily by two or three crops. The changes in land use have affected water management, resulting in continued expansion of saline-impacted soils. Concerned landowners and producers want to know what they can do to address the salinity issues in their soils.

Perennial forage grasses are often the best alternative to annual crop production for utilizing and reclaiming saline-impacted soils. Grasses provide continuous ground cover, forage for livestock, and habitat for wildlife. They improve the physical structure of the soil and improve water infiltration. However, there is still a question about which species of grasses will best establish and provide quality livestock forage in saline soils.

To address this need, the Bismarck Plant Materials Center cooperated with the NDSU Carrington Research Extension Center in a field trial to evaluate 11 cool-season grasses across a salinity gradient with electrical conductivity EC ranging from 3 to 21dS/m. Plots were seeded in 2 different locations in 2010, and forage was evaluated annually from 2011-2015. Grasses were clipped the 2nd week of July when most were physiologically mature. Clipping dates corresponded to a date when similar saline sites would be dry enough to harvest. Clipped samples were analyzed for biomass yield and forage quality.

Based on data from collected samples, each of the cool-season grass species in this trial were ranked for salinity tolerance and forage quality. Table 1 provides a summary of the salinity tolerance, production and quality of the species included in this trial. The complete summary of trial results are documented in Plant Materials Technical Note No. 1 available on the Bismarck Plant Materials Center website. This is valuable information for producers and landowners looking for perennial cool-season grass species that will address salinity concerns and provide quality livestock forage.

Table 1. Summary of saline tolerance, forage quality, and biomass production of cool-season grasses evaluated on a known salinity gradient in Carrington and Buchanan, North Dakota.

Cultivar/Common Name	Salinity Tolerance	Highest Salinity Range	Forage Quality	Biomass
'NewHy' hybrid wheatgrass	High	8.0-9.5	Good	Very Good
'Alkar' tall wheatgrass	High	8.0-9.5	Very Poor	Very Good
'Shoshone' manystem wildrye	High	8.0-9.5	Poor	Good
'AC Saltlander' green wheatgrass	High	8.0-9.5	Very Good	Very Good
'Saltlander' forage mix[1]	Medium High	7.5–9.0	Very Good	Very Good
'Rodan' western wheatgrass	Medium High	7.5-9.0	Fair	Good
'Garrison' creeping foxtail	Medium	6.0-8.5	Fair	Good
'Revenue' slender wheatgrass	Medium	6.0-8.5	Poor	Good
'Lincoln' smooth brome	Slight	5.5-7.0	Very Good	Fair
'Mandan' Canada wildrye	Slight	5.5-7.0	Fair	Good
'Fleet' meadow brome	Slight	5.5-7.0	Good	Fair

[1] 'Saltlander' forage mix consists of 50% 'AC Saltlander', 25% 'Revenue' slender wheatgrass, 25% 'Courtney' tall fescue

Cool-season perennial grasses established in saline soils at the Carrington, ND plots location. Photo Credit: Ezra Aberle, Carrington Research Extension Center.

IMPROVED FORAGE GRASS RELEASES BY THE BISMARCK PLANT MATERIALS CENTER AND PARTNERS

Wayne Duckwitz, USDA-NRCS,

Other Authors: Nancy Jensen, and Wayne Markegard, Bismarck Plant Materials Center

The USDA-NRCS Plant Materials Center (PMC) located at Bismarck, North Dakota cooperatively evaluates and releases forage grasses for improved livestock production. Twenty-five varieties of 15 different grass species have been cooperatively released for the purpose of improving the grazing and haying forage base for livestock operations primarily in the Northern Great Plains and Midwest. The forage types/sites include warm-season pasture and hayland; cool-season pasture and hayland; rangeland and wet and seasonally flooded areas. Forage quality parameters have been evaluated for many of these species in cooperation with North Dakota State University. The Bismarck Plant Materials Center is one of 25 PMC's strategically located throughout the United States. These centers develop conservation plants and plant releases that are used to help solve conservation resource problems on the landscape. Plant releases are generally performance tested and many of the plant attributes are clearly defined. This helps take the guess work out of selecting seed sources that are best adapted to the planting site. These plant releases are commercially available to the public and provide conservation benefits to resource agencies and the public in many of their vegetative planting projects. Plant parameters evaluated are dependent on resource needs. Such things as winter hardiness, drought tolerance, water inundation tolerance, disease resistance, biomass production, forage and wildlife qualities are just a few of the attributes that are tested prior to the plant being released for conservation plantings. These conservation plant releases are generally available as seed, but in some instances vegetative plant materials are also available. The goal of these plant releases is to provide a quality, performance tested product that is commercially available, economical, adapted to the site offers the desired conservation benefits. For more information on the USDA-NRCS Plant Materials Program visit the website at: https://www.nrcs.usda.gov/wps/portal/nrcs/main/plantmaterials/pmc/

DEFINING THE HISTORICAL BOUNDARIES OF THE GREAT PLAINS GRASSLANDS

Brice B. Hanberry, USDA Forest Service

Precise definition of the Great Plains grasslands has defied consensus, but historical vegetation reconstruction can provide a more authoritative boundary of the ecotone between the Great Plains and eastern forests. After comparing Great Plains boundaries, I developed an eastern boundary using evidence from historical tree surveys during the 1800s. Establishing the historical eastern boundary based on historical tree surveys contributes a solution to the debate over competing versions of the Great Plains.

The General Land Office conducted tree surveys at every 0.8 km (0.5 mile) of the midwestern U.S. during approximately 1785 to 1905. I used General Land Office surveys and reconstructions based on General Land Office surveys to determine whether ecological subsections had a greater area of prairie or forest. I merged this eastern boundary of grasslands with the Ecomap (Ecomap 2007) boundaries to reach a reconciled version of the Great Plains (Figure 1; Hanberry 2019a).

This Great Plains delineation departs from others primarily by including Illinois and small sections in Indiana and Wisconsin but excluding Missouri due to regular tree presence overall at landscape scales of ecological subsections. According to this definition, the Great Plains region covered 2.29 million km2 in 15 states, albeit only small extents in Indiana and Wisconsin. After removal of the Cross Timbers and other savannas in Oklahoma and Texas, the Great Plains

region covered 2.29 million km2. This GIS layer is available at the Forest Service archives (https://www.fs.usda.gov/rds/archive/; Hanberry 2019b).

Historical evidence from the 1800s helped differentiate the area of tallgrass prairie from tallgrass savanna, resolving the difficulty that caused disagreement in other definitions. Nonetheless, tallgrass prairie is continuous with tallgrass savanna and thus, precise division is not possible, even with perfect records and additionally, boundaries changed over time. Ecotonal areas remain where unclear separation between grassland and forest potentially could be reclassified.

Trees appear to have always been present in the Great Plains, existing in both the extremes of riparian wetlands and rocky escarpments. Historical savannas and woodlands of eastern oaks and western pines were compatible with fire and tallgrass prairie and also fire regimes were frequent enough to limit tree regeneration. However, the boundary between the Great Plains and eastern forests has been dissolving rapidly under current conditions, as trees expand into Great Plains grasslands. In contrast to fire-tolerant tree species, fire-sensitive tree and shrub species grow densely and out-compete herbaceous vegetation for growing space.

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Figure 1. Definition of the Great Plains based on historical tree surveys (dark outline), with delineation of the Cross Timbers (gray outline).

INTRODUCING THE RANGELAND PRODUCTION MONITORING SERVICE

Brice B. Hanberry, USDA Forest Service

Other Authors: Matt C. Reeves, USDA Forest Service

Throughout the Great Plains, aboveground annual net primary productivity (ANPP) is a critical ecosystem service, which often varies 40 percent among years due to fluctuating precipitation among other factors. We created the Rangeland Production Monitoring Service, a spatially explicit tool with automatic annual updates of ANPP for all rangelands in the coterminous US from 1984 to present (Figures 1 and 2). The Rangeland Production Monitoring Service provides national, state, and local answers to production and production deficits, trends, variability, recovery from drought or fire, and projections of fuel conditions before the fire season.

Relationships between Normalized Difference Vegetation Index (NDVI) from remote sensing imagery and ANPP from soil Ecological Site Descriptions were established to estimate ANPP. Validation metrics include an r2 of 89% between predicted and observed ANPP at three locations in the Great Plains. Significant ($\alpha \leq 0.05$) increases in ANPP since 1984 were observed across all major grassland types in the Great Plains, particularly the northern mixed grass prairie, which also has the greatest interannual variability (21%).

The RPMS uniquely quantifies production deficits due to drought, resulting in a new metric for drought that is ecological rather than meteorological and additionally tracks recovery after drought. The RPMS can provide guidance for amount of aid to producers during drought. This service enabled the USDA to provide relief in the form of emergency re-seeding provisions for areas most affected by drought. Currently, we are documenting the Rangeland Production Monitoring Service and increasing accessibility and usability. We also plan to add guidance about where, when, and what to plant to increase functionality.

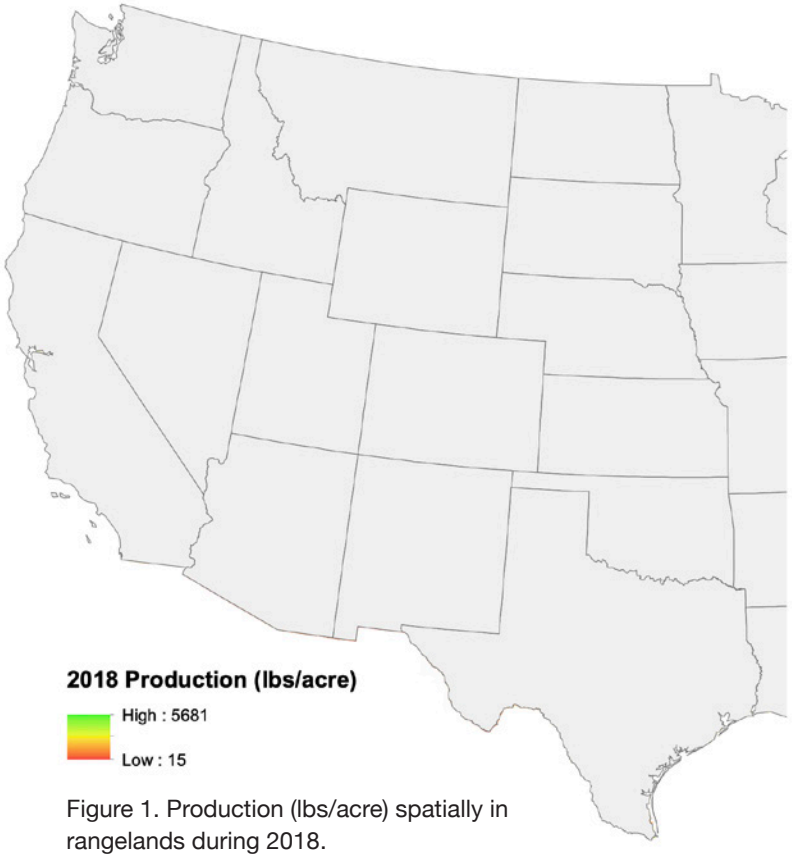


Figure 1. Production (lbs/acre) spatially in rangelands during 2018.

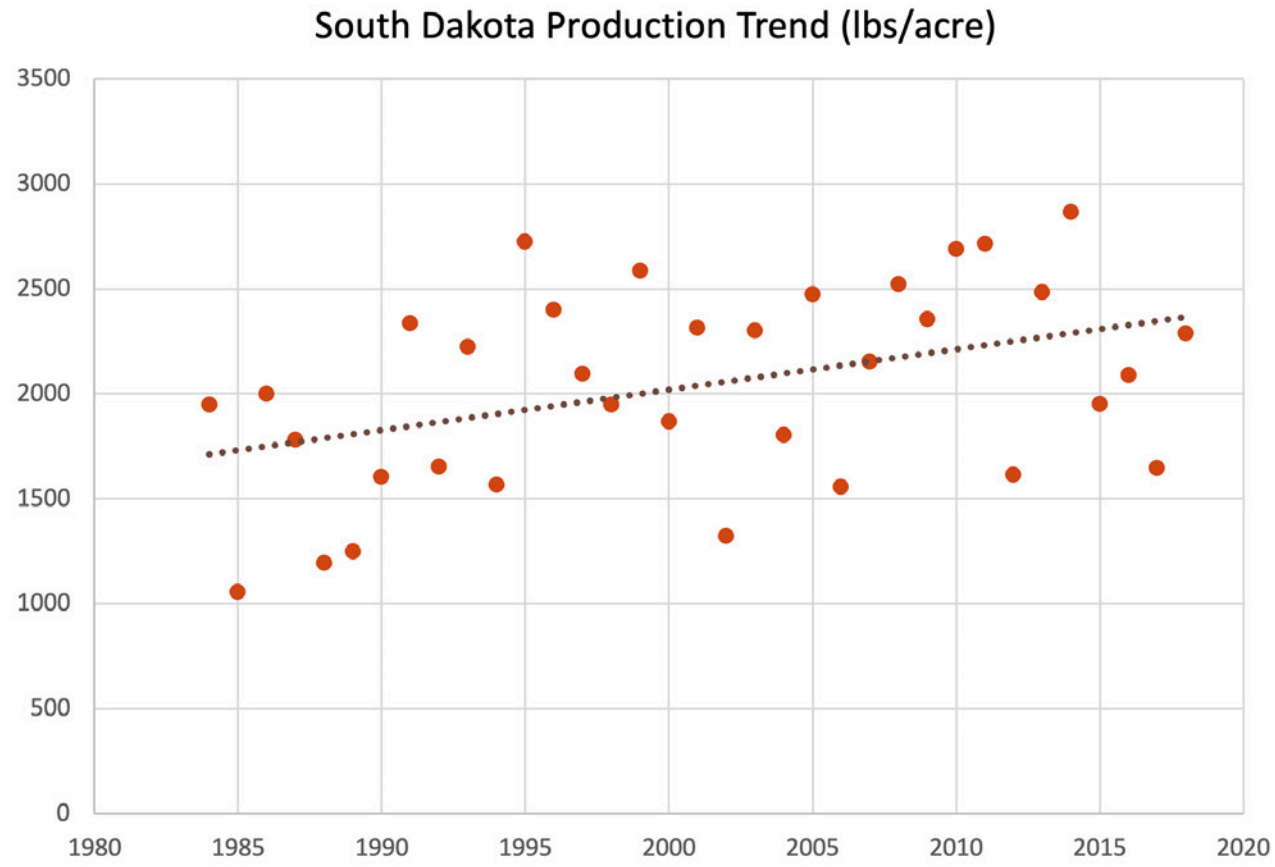


Figure 2. Production (lbs/acre) temporally in South Dakota during 1984 to 2018.

NATIVE SEED DEVELOPMENT FOR THE PINEY WOODS AND OAKS AND PRAIRIES REGION OF TEXAS

Tyler Wayland, Texas Native Seeds Program, Caesar Kleberg Wildlife Research Institute, Texas A&M University- Kingsville

Other Authors: Forrest Smith and Keith Pawelek, Texas A&M University- Kingsville

Native plant restoration efforts are in high demand in East Texas due to land use changes, increased highway and pipeline construction, energy production, and focused efforts to offset habitat fragmentation due to urbanization and development. These demands for restoration efforts have highlighted the need for greater diversity, quality, and quantity of locally-adapted native seed from commercial seed suppliers. Lack of commercial sources of locally-adapted native seed puts land managers and project managers in a forced situation to utilize seed without any demonstrated adaptability, longevity, or true adaptation to East Texas, resulting in many native plant restoration seeding failures.

Research over the last two decades has strongly and consistently correlated native plant restoration success with the use of locally-adapted or ecotypic native seed sources. *East Texas Natives (ETN)* is working to develop needed ecotypic seed sources of native plants from the East Texas region that will ultimately be made available for purchase and use in public and private restoration efforts in the piney woods, oak woods and prairies, and blackland prairie ecosystems.

ETN is a collaborative initiative to develop and promote regionally adapted native seed sources for use in restoration and reclamation efforts on private and public lands of East Texas. The project's objectives are:

1. To collect, evaluate, and release locally adapted native seed sources for East Texas to commercial seed producers in order to facilitate availability of locally adapted native seeds to all consumers in the region.

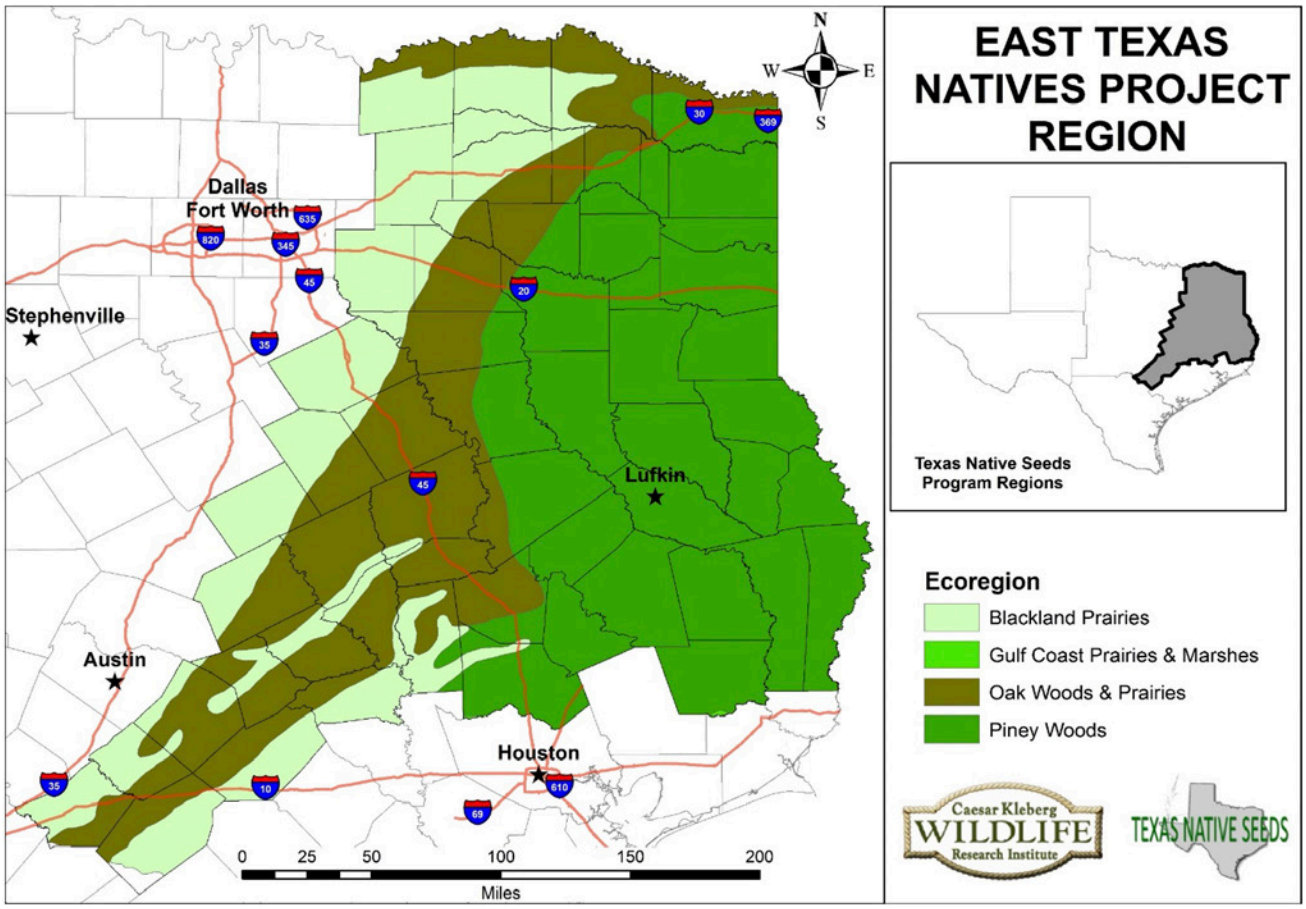
2. To develop and implement restoration and reclamation strategies that can be successfully used to reestablish native plants in disturbed or degraded habitats in the region.

3. To promote the use of native plants in pastures, timber operations, rangeland and prairie restoration, and for highway, oil and gas, and energy transmission rights-of-ways reclamation.

The project is based on a proven model of native seed source development followed by similar initiatives in South, Central, and West Texas over the last 18 years, and in East Texas, the Permian Basin, and Coastal Prairie regions for the last 2 years. *ETN* is part of the statewide T*exas Native Seeds Program* operated by the Caesar Kleberg Wildlife Research Institute at Texas A&M University- Kingsville, and includes many private, state, and federal cooperators.

ETN uses common garden studies to identify best-performing regionally adapted native plant populations for restoration plantings and commercial scale seed production.

The project's first native plant evaluation studies were established in May 2019 at the East Texas Plant Materials Center (ETPMC) in Nacogdoches, Texas, and at Daisy Farms in Paris, Texas. Indiangrass and



The East Texas Natives project region.

Silver bluestem evaluation study at the East Texas Plant Materials Center in Nacogdoches, Texas.

silver bluestem were the first two species selected for evaluation in the region because of their important roles in many plant communities and because adequate numbers of collections had been obtained in the first 2 years of the project. Native populations, alongside any existing commercial varieties, are being evaluated over a 2-3 year period at each site. At the completion of the study, seed from selected accessions will be grown in seed increase fields to produce enough seed for commercial growers and experimental use. Following successful increase and performance testing, research findings will be published, and resulting seed sources will be released for commercial production as a certified Texas Select Native Germplasm.

GRASS AND FORB FIRE RECOVERY BENEFIT FROM ANT AND KANGAROO RAT BURROWS IN A SEMIARID CENTRAL PLAINS GRASSLAND

Nancy Nicolai, University of New Mexico & Sevilleta National Wildlife Refuge

Background & Hypothesis

Banner-tailed kangaroo rats *(Dipodomys spectabilis)* and rough harvester ants *(Pogonomyrmex rugosus)* contribute to a grassland mosaic of vegetation patches. They add productivity by creating soil-modified nests and adjacent edges which are typically superior in soil nutrients and soil characteristics (Moorhead et al. 1988, Wagner and Jones 2004) compared to surrounding habitat. They can alter water availability, fungi (Hawkins 1996), seed banks (Koontz and Simpson 2010, Nicolai and Boeken 2012) unique to the surrounding landscape. The rats' nest and mound are continually changed by construction and by throwing soil, excrement and plant debris outside the burrow (Guo 1996). Similarly, harvester ants have a 1-m diameter, bare soil disk on top of their nest by continually removing vegetation and by accumulating debris (MacMahon et al. 2000). Encircling rat and ant mounds is an edge zone of lesser soil maintenance. These are soil resource patches for plants which can alter plant species composition (Whicker and Detling 1988, Alba-Lynn and Detling 2008) and increase diversity and productivity (Nicolai et al. 2008) including reproduction.

After a large-scale disturbance such as fire, plant colonization and regrowth may subsequently differ on these soil resource patches perhaps recovering faster. I hypothesize that grasses and forbs at banner-tailed kangaroo rat and rough harvester ant patches would recover quicker than surrounding grasslands after fire.

The Research

The study was conducted on the Sevilleta National Wildlife Refuge, New Mexico, USA. The climate is semiarid, mid-elevation continental. Mean annual precipitation is 9.4 in. and mean temperatures are 96 0F in July and 36 0F in December (Refuge Records 1989-2009). Except for the first spring after the fire, climate during the study was much dryer and warmer than average including 83% below it during the first summer. Study site vegetation is dominated by a mixture of perennial grasses with approximately 40 forb species while shrubs and cacti dot 25% of the site.

The Black Butte Wildfire resulted in nearly 100% of the study site's aboveground vegetation being consumed by fire, leaving scorched stubble. Postfire observations indicated that vegetation and litter at rat and ant nest patches burned similarly to surrounding grassland. Twenty rat nests and twenty ant nests were randomly selected for data collection in the burned study site.

Data collected were percent cover, density, species number, and frequency of seed stalks at three zones on each nest; nest top (mound), area encircling the mound (edge), and 20 m (control) from the edge two years postfire. One sample was collected randomly on each zone. Data from each species were summed for five groups; grass, perennial forb, annual forb, subshrub, and shrub. I compared group variables using an analysis of variance statistical design. Planned Comparisons were conducted to determine differences among zones for each animal species. Chi Square Test of Association was used to compare the frequency of number of seed stalks with animal species and zone.

Cover, density and species number were generally low on animal mounds (Nicolai 2019). At rat edges, perennial forb density (5.0 m2, 2.0 SD) recovered faster compared to controls (3.5 m2, 2.0 SD, $P < 0.05$). Perennial forb species number also recovered faster at rat edges (3.2 in quadrat, 1.5 SD) than controls (2.4 in quadrat, 1.0 SD, $P < 0.05$). Ant edges yielded faster recovery of grass seed stalks per individual (89% had high frequency of grass stalks) than controls (57%, $P < 0.007$).

Conclusions & Management Implications

My results in this semiarid ecosystem suggest that these animals create patches with superior soils conditions enhancing establishment and survivorship of recovering dicots and reproduction of recovering grasses. It is unknown how fire intensity may add to nest patch recovery. Equal regeneration between animal nest and grassland occurred commonly when fire reduced dominant grass competition (Nicolai 2019). As areas of high grass reproduction during recovery, ant patches may act as foci for seed dispersal into surrounding habitat. And with greater dicot establishment, rat edges may be sources for reestablishment.

These results improve our understanding of plant responses after fire. Recovery of grassland may be amplified as plants infill from animal-created patches. Recovery after large-scale disturbances may be facilitated by numerous small-scale modifications by these little animals. My study indicates that managers might positively influence recovery in semiarid grasslands by maintaining habitat for healthy populations of patch engineers.

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IMPLEMENTATION AND EVALUATION OF A COMPREHENSIVE MANAGEMENT METHODOLOGY IN BEEF CATTLE ENTERPRISES IN CHIHUAHUA, MÉXICO.

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Other Authors: Elco S. Blanco Madrid, and Jesús A. Almeida Valdez, Centro de Recuperación de los Recursos Naturales, A. C.

Introduction

To regenerate and conserve the degraded grasslands, there is a management methodology used by some ranchers for many years, but there is little data of the positive results they have achieved.

The present study measured, during a four year period, the differences or impacts in grass basal cover, bare soil percentage, and benefit-cost analysis, obtained by implementing a Comprehensive Management Methodology in Beef Cattle Enterprises, in four ranches in the State of Chihuahua, México.

Objectives

The data obtained herein, answer many of the questions that a lot of professionals and ranchers have about this methodology, and moreover it shows evidence that this Comprehensive Management is a proved option to recover the grasslands and reduce or stop desertification, while improving profitability, practically in every type of grassland.

Methods

The methodology used to monitor and document the vegetation changes (botanical composition) was the Line Intercept, and the Financial Planning methodology proposed by Allan Savory, was used to calculate the production and economic parameters. During

Monitoring and documenting vegetation changes. Photo: Elco S. Blanco Madrid

Table 1: Findings obtained in the study.

Ranch	Grass basal cover (%)		Reduction in bare soil (%)	Production (lb/ac)		Benefit-cost analysis (%)	
	2007	2011		2007	2011	2007	2011
Cuevitas	4	11	18	7.98	5.64	-2.01	98.57
Las Ranas	5	13	13	17.35	20.17	31.40	46.94
Los Ojitos	10	19	26	7.25	10.9	-8.23	-9.11
Los Robles	17	22	4	12.64	11.01	-0.44	138.51

the period of the study, frequent interviews were undertaken with the land owners, as well as with the people involved in the operation of the ranches.

Findings

As shown in Table 1, the four ranches obtained increments in grass basal cover, and reduction in bare soil percentage.

In Cuevitas Ranch the production parameter showed a decrease, due to a stocker operation with high bank interests, deciding to sell all the steers and pay the loan, which led to improve the overall profitability.

In the benefit-cost analysis Los Ojitos Ranch presented a decrease from -8.23 to -9.11%, due to an investment in an orchard plantation.

Conclusion

By implementing this Comprehensive Management Methodology, the grasslands gradually recovered their plant cover and production level, reducing the bare soil areas, which led to reverse the process known as desertification, and enhance the profitability of the ranches, offering the land owners a better quality of life.

Bare soil covered by Blue Grama *(Bouteloua gracilis)* and Arizona Cottontop *(Digitaria californica.*
Photo: Elco S. Blanco Madrid.

Paddock completely recovered. Note the height of the grasses with the top of the fence posts (on white). Photo: Elco S. Blanco Madrid.

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IDENTIFYING POTENTIAL LANDSCAPES FOR CONSERVATION ACROSS THE CENTRAL GRASSLANDS OF NORTH AMERICA: INTEGRATING KEYSTONE SPECIES, LAND USE, AND CLIMATE CHANGE

Ana Davidson, Colorado State University

Other Authors: David Augustine, USDA-Agricultural Research Service; Michael Menefee, CSU; Michelle Fink, CSU; Lindsey Sterling-Krank, Prairie Dog Coalition; Bill Van Pelt, Western Association of Fish & Wildlife Agencies

Our team is developing a large-scale collaborative conservation planning initiative for North America's central grasslands. This effort will focus on black-tailed prairie dog (BTPD) ecosystems. Prairie dogs are keystone species and their conservation and management often lies at the core of many conservation efforts across the region (Fig.1) (Kotliar et al. 2006, Davidson et al. 2012, U.S. Fish and Wildlife Service 2013). Through mapping and ecological modelling, our team is working to identify potential landscapes for conservation that will consider ecological, political, and social factors, along with changing climate and land use to maximize long-term conservation potential and co-existence with human activities. This is a multi-year project, and we are currently in year one. Our primary goals are to: 1) generate a BTPD habitat suitability model; 2) incorporate future climate change predictions into a BTPD habitat suitability model; and 3) identify landscapes with high conservation potential within predicted suitable habitat, both now and into the future, under changing land use and climate.

Our project brings together scientists, conservation groups, and agencies to collaboratively develop the decision support tools. The habitat suitability models, multiple scenarios and prioritization will be informed and reviewed by experts and managers, including the

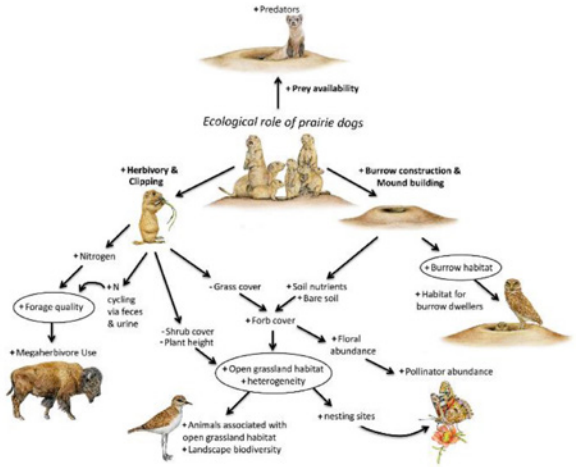

Fig. 1. Ecological role of black-tailed prairie dogs. + signs indicate increase and – signs indicate decrease. Drawings by Sharyn Davidson.

Western Association of Fish and Wildlife Agencies' (WAFWA) Prairie Dog Conservation Team (PDCT), State BTPD Working Groups, and Expert and local manager insight. We aim to co-create a planning tool for optimizing and guiding grassland conservation and management efforts across the Great Plains, using state of the art maps and models for the prairie dog ecosystem. The planning tool will help provide a road map of desired conservation gains for North America's central grasslands. This work will build substantially on previous conservation recommendations for black-footed ferret recovery, and inform management on other species of conservation concern associated with BTPDs. Additionally, it will identify regions with greatest leverage for land exchanges and purchases, conservation easements, and use of incentive or mitigation funds for restoration, and refine existing efforts like those being implemented under the WAFWA Grassland Initiative Planning tool for optimizing and guiding grassland conservation and management efforts across the Great Plains.

We are grateful for federal funds from the Fish and Wildlife Service, a division of the United States Department of Interior, administered by the Kansas Department of Wildlife, Parks and Tourism. The contents and opinions here, however, do not necessarily reflect the views or policies of the United States Department of Interior or the Kansas Department of Wildlife, Parks and Tourism.

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GRASSLAND MANAGEMENT REQUIRES ADAPTIVE MANAGEMENT TO TAKE BIGGER RISKS AND LEARN FROM FAILURES

Jack Norland, North Dakota State University

Other Authors: Cami Dixon, U.S Fish and Wildlife Service; Benjamin Geaumont, North Dakota State University

Human managed grasslands are complex adaptive systems (Levin et al. 2013) that tend to share the following characteristics: 1) non-liner effects, 2) hindsight does not equal foresight, 3) uncertainty increasing with time, 4) self-organization with emergent patterns arising, and 5) adaptation to changing conditions. One aspect of dealing with complex systems is that the emergent properties of those systems such as vegetation communities often follow frequency distributions that are best characterized as fat-tailed (Batt et al. 2017; Norland et al. 2018). In fat-tailed distributions, the tails of the distribution often contain extreme events at higher frequencies than would be predicted under a normal distribution (Figure 1). The expected events normally have some basis in known science and to a certain level are predictable. The extreme events often have little knowledge on how they occur and are much less predictable, but they also have inordinate effects such as earthquakes or management actions that fail – "All we have now are invasive species". These extreme events are often what land managers are asked to respond to, but because they are complex, managers have limited knowledge and experience with them. Using past experience and applying what is known from the expected events often leads to poor explanations and the inability to come up with effective solutions.

One strategy to deal with extreme events is to use adaptive management. Adaptive management is simply to learn by doing, but this learning is not always done in rigorous conditions as demanded by experimental research (Biggs et al. 2015). Often adaptive management is a trial and error method where one is searching for emergent patterns. When such extreme events occur, one has to be opportunistic to apply adaptive management. In addition, managers and researchers may have to be innovative and replicate conditions found in extreme events in order to study their effects and the emergent patterns that arise from complexity. Use of adaptive management in this way has risks. Often failure is the most likely outcome from such experiments. However, in some ways adaptive management is about exploring such failures so one can learn. This applies best to extreme events where not much is known and often failures are the best way to learn. The saying "fail fast and learn faster" sums up this strategy on how to deal with complexity. To deal with the consequences of failures Snowden and Boone (2007) have advocated doing "safe-to-fail" experiments where the consequences of the experiment are contained and adverse effects are minimized. Using this strategy allows managers who enact adaptive management to be innovative and justify risky, high probability of failure experiments. The reward for taking these risks is the ability to learn from failures. Such a strategy will help managers "plan for the expected and prepare for the unexpected" (Dahlberg 2015).

Preparing for the unexpected becomes even more imperative as one contemplates future grasslands. Future grasslands will likely be different from the current grasslands with new fat-tailed events occurring due to factors like directional change in land use, climate change, and economics (Figure 2). When grasslands are subject to these directional changes, forecasting is often useless. To cope with such uncertainty, adaptive management will need to explore these new fat-tailed events. What form these potential events may take, will require managers and experimenters to be imaginative and go with their "hunches". Even though these imagined futures may be unlikely, a commitment to designing experiments that explore such future events has the potential to demonstrate how emergent patterns might occur in other future outcomes. Again, failure through planned research will help managers and researchers learn and be more adaptable, but done in a "safe-to-fail" way. The willingness to create failures will require daring, gutsy, and confident land managers. Such managers will need to be fast learners and always be looking for ways to take risks so they can learn more.

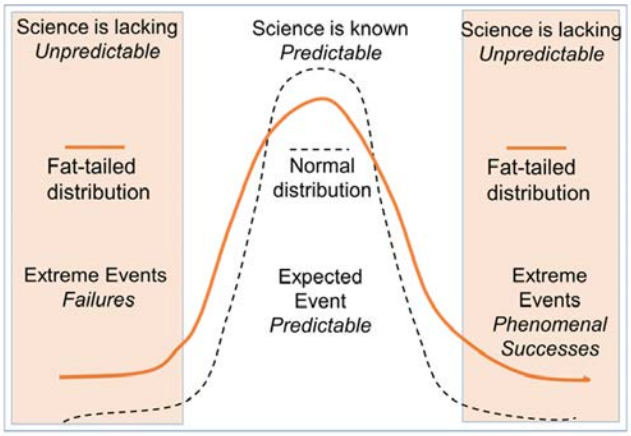

Figure 1. Comparison of fat-tailed distribution from complex systems with a normal distribution and how science contributes to the tails.

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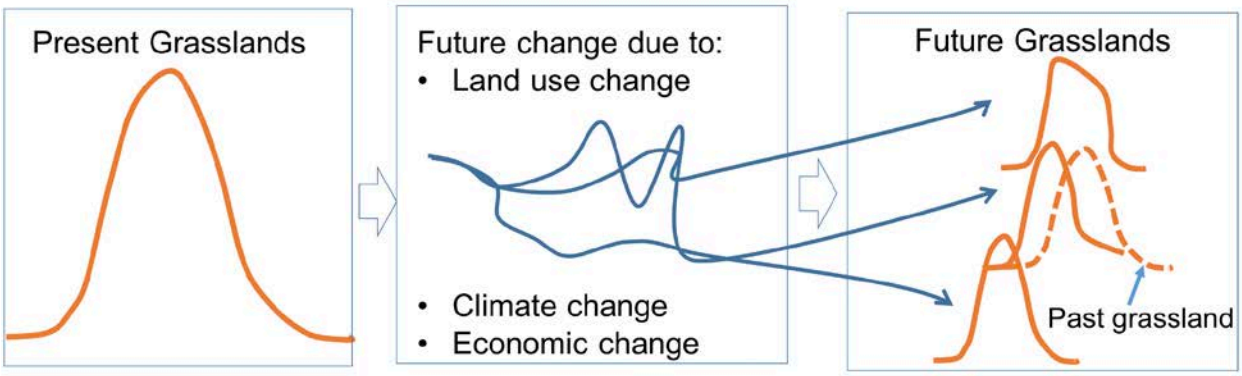

Figure 2. Conceptual model of how current grasslands develop into future grasslands.

BOBOLINKS AND BOVINES: GRASSLAND BIRD CONSERVATION THROUGH ADAPTIVE MANAGEMENT GRAZING

Mary Damm, PhD, Prairie Quest Farm

Other Author: Phil Specht, Prairie Quest Farm

Prairie Quest Farm is located in the Driftless Region of Northeast Iowa along the bluffs of the upper Mississippi River and within the Effigy Mounds - Yellow River Forest Globally Important Bird Area, designated by the National Audubon Society in 2014. The majority of the farm is planted in perennial cool-season grasses and legumes for rotationally grazed pastures. Over the past two decades, the farm has been managed for the production of forages for grass-fed beef and dairy cattle as well as habitat for breeding grassland birds. Grassland birds as a guild declined by 53% since 1970 across the United States and Canada (Fitzpatrick and Marra 2019). Specific grassland bird species (Eastern Meadowlark, Dickcissel, Savannah Sparrow, Grasshopper Sparrow, Western Meadowlark, and Bobolink) declined by 61 to 93% between 1966-1991 in neighboring farm-state Illinois (Herkert 1994) likely due to the conversion of diversified farms with pastures and hayfields to intensively managed farms of corn and soybeans (Herkert et al. 1996).

Adaptive Management Grazing

Forages for feeding ruminant livestock can be managed in many different ways, from monocultures of intensively cut alfalfa hayfields to much less intensively utilized permanent pastures. With an adaptive management grazing system, we attempt to harvest as much plant biomass as possible without negatively affecting the ecosystem in other ways (e.g., soil erosion, water pollution). Nature provided a blueprint for our pastures with the tallgrass prairie that built the soils near our farm, so we start with the observation that prairies consist of a diversity of plants that vary seasonally and vary among micro-environments, and provide habitat for insects, birds, and other animals. We then attempt to replace the grazing and browsing bison and elk of the former prairie with cattle and plan a grazing rotation for the cattle that mimics the movement of native mammals. This managed grazing system creates a mosaic of different grass heights and maturities and creates a habitat especially suited to grassland birds.

The basic management is to gather the cattle in a paddock (sub-division of a larger pasture) and allow the animals to eat half the plants. The cattle are then moved to the next paddock leaving behind the remaining half of plants. The plants in the first paddock are left to regrow until at least as much as what was eaten is available again for grazing. Cattle eat the leaves with the highest sugar content first, and will ignore regrowth if moved in a timely manner. This provides enough leaf surface to continue the transfer of the simple sugar product of photosynthesis to the roots, where carbon is exchanged for nutrients with the soil microbes for further plant growth. This pattern of grazing followed by regrowth is repeated again and again throughout the growing season. Manure from the cattle is spread evenly across the paddocks returning nutrients and minerals needed for plant regrowth. The "adaptive" part of the system requires observation so as to vary cattle stocking density and duration in a paddock to be suitable for pasture conditions at any given time.

As a result of our adaptive management grazing system, there are a number of habitats on the farm including: grasslands of cool-season pasture and reconstructed tallgrass prairie, savannas of native hardwood trees and trees planted along fencerows and on former row-crop terraces, and ponds with open water and in dry years, bare-ground shoreline.

Conservation Stewardship Program

In 2015 we enrolled the majority of the farm (365 acres) into the USDA Natural Resource Conservation Service's Conservation Stewardship Program (CSP)

to achieve our dual management goals of producing food and providing wildlife habitat, particularly for grassland birds. The CSP was first introduced in the 2002 Farm Bill to financially reward farmers for conservation practices on working farms. In 2015 the CSP offered 119 practices including provisions for maintaining and restoring farmland for plant species diversity and ecosystem function. We selected nine CSP practices in three general areas (pasture maintenance, habitat restoration, and research and education) in order to maintain the high quality pasture-grassland, plant prairie and hedge row habitats, and research and educate others about adaptive management grazing and bird habitat on Prairie Quest Farm.

Pasture Maintenance

Our specific goals were to move cattle throughout the growing season by dividing larger pastures into smaller paddocks and prevent overgrazing of the pasture plants. To accomplish these goals, we enrolled the farm into the following CSP practices: Intensive Rotational Grazing, Rotation of Supplement and Feeding Areas, Monitor Pasture Health Using Pasture Condition S cores, and Monitor Key Grazing Areas to Improve Grazing Management.

Habitat Restoration

Our specific goals were to plant new and add seed to existing reconstructed tallgrass prairie and plant hedgerow shrubs to create a farm border. We enrolled the farm in the following CSP practices: Establish Pollinator and Beneficial Insect Habitat, Incorporate Native Grasses and Legumes, and Increase Food Production with Edible Woody Buffers.

Research and Education

Our specific goals were to study soils in the farm's pasture, reconstructed prairie, and undisturbed savanna and teach other farmers adaptive management grazing. The specific CSP practices that accomplished these goals included: Utilize the Soil Health Nutrient Tool (Haney Test) and Host a Grazing Field Day.

Prairie Quest Farm Research

We began sampling breeding Bobolink populations in 2015. We established ten 200' x 300' plots in the pastures to measure grass height and number of active nests during the breeding season (mid-May to early July) and sampled the plots each of the past five years. Within four of the plots, we established 100' transects to intensively sample vegetation and soils in ten 1' x 2' quadrats. We sampled plants at different times during the grazing rotation for species diversity, aboveground plant biomass, grass and legume height, and litter depth and biomass. We collected ten soil cores along each transect to a depth of approximately six inches and pooled the cores in a bag. The bags were sent to Ward Laboratories, Kearney, Nebraska, for the Haney and Phospholipid Fatty Acid (PLFA) soil health tests to document soil microbial activity and functional group biomass. We also observed and recorded all breeding bird species on the farm throughout the year. In 2019 we began recording male and female Bobolink vocalizations and began a collaboration with Paul Skrade, professor at Upper Iowa University, to research the number of successful Bobolink nests (nestlings present).

Prairie Quest Farm Breeding Bird Species List

Pasture-grassland birds: Killdeer, Eastern Kingbird, Barn Swallow, Sedge Wren, Dickcissel, Field Sparrow, Grasshopper Sparrow, Henslow's Sparrow, Savannah Sparrow, Song Sparrow, Eastern Meadowlark, Western Meadowlark, Bobolink, Brown-headed Cowbird, Red-winged Blackbird, American Goldfinch.

Pasture-savanna birds: Mourning Dove, Red-bellied Woodpecker, Red-headed Woodpecker, Eastern Wood-Pewee, Acadian Flycatcher, Eastern Phoebe, Tree Swallow, Black-capped Chickadee, Eastern Bluebird, Gray Catbird, Brown Thrasher, Cedar Waxwing, Yellow Warbler, Common Yellowthroat, Summer Tanager, Northern Cardinal, Rose-breasted Grosbeak, Baltimore Oriole.

Pond birds: Green Heron, Canada Goose, Wood Duck, Mallard, Hooded Merganser, Bank Swallow, Northern Rough-winged Swallow.

Game birds: Gray Partridge, Ring-necked Pheasant, Wild Turkey.

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Photo credit: Phil Specht, Male Bobolink perched on pasture fencepost on Prairie Quest Farm.

Photo credit: Phil Specht, Five juvenile Bobolinks perched on goldenrods on Prairie Quest Farm.

ROUND TABLE DISCUSSION NOTES

LAND USE DECISION MAKING ROUNDTABLE DISCUSSION

Moderators: Hongli Feng, Michigan State University and Adam Reimer, National Wildlife Federation

Attendees:

- 20-30 (fluctuated some during the 45 minute session)
- 10-12 spoke, most participants seem actively engaged in the discussion
- Appeared to come from a range of backgrounds (agencies, NGOs, ranchers), though ranchers seemed under-represented among speakers

Discussion Notes:

- We prompted the discussion with a question: What are the biggest challenges you or others you work with face when it comes to grassland conservation? We indicated we were interested in a variety of contexts, including working lands, public lands, and public-private land interfaces
    - There was some initial confusion over the topic of discussion: some thought the discussion would be more about decision tools or rubrics to assist land managers with grassland management decisions. We steered the conversation away from this to stick with one (already broad) topic
- Participants identified a number of barriers to grassland conservation: economics, organizational, and sociopsychological

- **Economic barriers:**
    - The first major theme was the economic disincentives for grassland conservation, especially competition with crop production
    - Crop production was seen as driven by government policy and international market actors through subsidies and price premiums
    - Crop production also tied to "caring less" about the land, seen more as an input-driven industrial system—tying economic incentives to social norms
    - A few ranchers expressed very strong opinions on this, indicating the emotion of this issue

- **Organizational:**
    - Government incentives for grassland conservation are not seen as sufficient, and not available in all contexts (Canada vs US)
    - Other actors might be needed to provide economic incentives: NGOs, foundations, market-based mechanisms
    - There is a need for more consumer/public education and mobilization on grassland conservation to support public and market-based incentives for grassland conservation
    - NGOs may be better providers of incentives, are seen as more trustworthy than government agencies by some
    - GOs need more organizational support and tools to be more active proponents of grassland conservation

- **Social/cultural:**
    - Social norms are often a barrier to conservation: coffeeshop talk, social pressure to conform with common practice (standard grazing vs rotational grazing), the need to push production metrics (yield, animal weight, etc.)
    - Grassland conservation and rotational grazing practices aren't often discussed, especially between ranchers and landowners, ranchers and public, even among ranchers themselves
    - Time management is a major constraint for some: ranchers often have off-farm employment, don't have time to investigate new practices,

may perceive rotational grazing as less optimal for them
    - Availability of technical and information resources is a related challenge: one rancher said she had to create her own social and technical network for small ruminant grazers because nothing like that existed
- We pivoted in the last 10-15 minutes to solutions to these barriers: This is always a challenging transition, because it can be easy for participants to dwell on the challenges. Given the short time we had, I thought the conversation was productive
- Solutions to economic and policy barriers centered on changing subsidy and agricultural policies to "level the playing field" between grazers and crop producers
    - Change federal subsidies to reduce support for cash grains and beans
    - Make conservation programs more flexible
    - Find alternative (local) partners to administer programs
    - Develop new market mechanisms to incentivize grazing in general and good grazing practices in particular lucrative: could be private, public, or some combination, we did not get too much into specifics
    - Involving consumers in markets by building understanding is also seen as key
- Social/cultural
    - Many emphasized the need for peer-to-peer networks and more collaborative approaches among ranchers to promote grassland conservation
    - Agency and NGO employees emphasized the need for relationship building, which takes time but can pay off in the long run. This is seen as the only way to build trust and overcome past friction between stakeholders
    - Changing norms and mindset is seen as a key longterm strategy, but few specifics about how to do this on a large scale

SCIENCE COMMUNICATION FOR NATURAL RESOURCE OUTREACH

Moderators: Susan Ellis-Felege and Collin Riley, University of North Dakota

Science has always been a difficult concept to explain to a diverse audience. However, there is a basic need for environmental literacy (Bickford et al. 2012), especially in the face of the many conservation challenges that require support from society and policy makers. Science communication is a crucial step that is often overlooked by researchers, trained to communicate with other researchers in their disciplines, but not necessarily with the general public. Communication with the public is essential to bridge the gap in the understanding of science and conservation for the future.

The use of social media platforms such as Twitter, Facebook, and Instagram, as means for science communication has become a common approach (Di Minin et al. 2015). Twitter has become known for science communication and often a platform for communication among scientists (Bombaci et al. 2016). In fact, research suggests that tweets posted on Twitter highlighting research result in that published research obtaining more citations than those not shared on Twitter (Lamb et al. 2018). In addition to Twitter, media platforms, such as Facebook, Instagram, and YouTube cater to additional audiences and demographic groups, facilitating opportunities for communicating science and conducting outreach efforts.

We demonstrated how an active wildlife research project and its associated communication could be used to better understand an audience in order to develop strategies for natural resource outreach. Our team developed a media plan, analogous to a wildlife management plan, which included defining a clear objective and then an analysis of strengths, weaknesses, opportunities, and threats (SWOT) of the approaches proposed to achieve your outreach/communication objectives (Helms & Nixon 2010).

Team members posted pictures, videos and facts on our Facebook, Twitter, YouTube, and Instagram pages. Given the limited budget we primarily used available equipment such as phones and laptop computers owned by the project and team members. We eventually incorporated image and video collection from digital single lens reflex (DSLR) and GoPro cameras to capture higher quality content. Freely available software such as Tweetdeck (https://tweetdeck.twitter.com/) and Hootsuite (www.hootsuite.com) helped facilitate postings that could be scheduled to maximize efficiency in sharing materials.

After each field season ended, we created surveys to better understand follower demographics and how they changed through organic growth (i.e., we did not pay for any commercialization to enhance our follower-base). We used one survey administered through our social media pages and one survey through an available student subject pool to compare follower and non-follower differences, and how our followers changed from the first year (2017) to the second (2018). Most notably we found that our audience was not like the general public, and already shared attitudes the project would like to influence the public to have. We had an increase in followers in year 2, where 40% fewer had a personal connection to our research team, meaning they were more likely to be part of the "general public" the project targeted. Our findings suggest social media targets those of like-mindedness and narrower audiences than the conservation community might think we are reaching in an outreach effort to change attitudes, especially at early stages of the project's development.

To determine the impact of your social media efforts, projects can harness the analytics or insights pages available on platforms such as Twitter and Facebook that show what types of posts have the most engagements (e.g., shares or likes) and which are reaching the most people. Our research and that of others (e.g., Kim 2016; Carboni & Maxwell 2015; Ashley & Tuten 2014, etc.) suggests that the use of images and video increase engagements across platforms, but the content which is used within those images and videos may need to be catered to the specific platform used because platforms are often preferred by different user groups.

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THE NEED FOR A TRI-NATIONAL GRASSLANDS INITIATIVE

Moderators: Cliff Wallis, Alberta Wilderness Association and Michael Gale, U.S. Fish and Wildlife Service

There are ongoing discussions between the USA, Mexico and Canada on a Trilateral grasslands initiative.

A strong domestic effort is needed in all three countries and assistance is needed from civil society individuals and groups to raise the profile of grassland conservation issues.

There are lots of smaller local initiatives but there is not enough transboundary cooperation across all three jurisdictions or a major funding mechanism to support landscape level conservation across boundaries.

A Great Plains/Grassland conservation framework is needed.

Leadership is needed to take this on.

The Hohhot Declaration on grassland conservation was produced in 2008 and another such declaration could come from a future grassland conference, e.g. Central Plains bird summit 2020 in Denver.

There is some momentum with the Great Plains Conservation Network to cross fertilize with the bird summit.

The Association of Fish and Wildlife Agencies is currently doing a gap analysis. They will produce a layer of who is doing what and where in a database.

There is a need for NGOs to step up policy influence. In many cases, it is easier for NGOs to do trans-boundary work than government employees.

Put value on ecosystems.

Recognize importance of grasslands and their goods and services and get trinational tools to support its conservation.

Using more of the agricultural dollars to fund grassland conservation instead of its destruction.

Incentives for ranchers could leverage grassland conservation work, e.g. carbon offset potential to keep prairie native, e.g. carbon sequestration protocol in Canada.

Agree on opposing conversion of native grasslands to annual crops and other non-native species.

Land trusts can play an important role in conservation on private lands.

More resources and capacity building for tribes and First Nations is needed; could support bison and grassland conservation and a wide-range of species of conservation concern.

Need shared language across different grassland landscapes.

Common communication products, unified message, e.g. no conversion of native grasslands.

Power of collaboration

Canadian Roundtable for Sustainable Beef is an example of a multi-stakeholder initiative trying to leverage support from industry for grassland conservation

Science based conservation is essential but also need to recognize ways to support healthy and prosperous human communities that practice grassland conservation.

Climate change threat acknowledged, and resilience of native grasslands needs emphasis.

Science practitioners have their own networks, e.g. grassland restoration network; need more cross-network communication and more unified funding system.

Gap in how to implement learnings from science into management and policy.

Environmental NGOs can help in communication and advocacy.

SE grasslands (non-Great Plains) haven't been recognized but were there historically (now forested).

RANCHER PLENARY PANEL

Rancher panel with representation from Canada, the U.S. and Mexico. Moderated by Kevin Kading, N.D. Game and Fish.

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