AMERICA'S GRASSLANDS CONFERENCE

PARTNERSHIPS FOR GRASSLAND CONSERVATION

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

SEPTEMBER 29 - OCTOBER 1, 2015 • FORT COLLINS, COLORADO

AMERICA'S GRASSLANDS CONFERENCE: PARTNERSHIPS FOR GRASSLAND CONSERVATION

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September 29 - October 1, 2015
Fort Collins, CO

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CONTENTS

INTRODUCTION TO THE PROCEEDINGS

In early fall of 2015, the National Wildlife Federation hosted the third America's Grasslands Conference – in Fort Collins, Colorado in partnership with Colorado State University and the Bird Conservancy of the Rockies. As a harbinger of conservation successes and lessons learnt, one of the field trips was to the Soapstone Natural Area where a few weeks later, a herd of Bison charged in to the public grassland for the first time in a century and a half. The conference centered on promising partnerships for grassland conservation and was attended by over 230 participants with diverse backgrounds from researchers and conservationists to producers and policymakers. The conference ran from September 29th to October 1st and featured over 70 speakers including a moving keynote by Carol Davit on the incredible diversity and value of native prairies and the difficult task of making grassland conservation relevant to the American public. It featured optional field trips to Soapstone Prairie Natural Area and the Pawnee National Grasslands, a poster session, a series of roundtable discussions, and a picnic at nearby Sylvan Dale ranch (with cowboy singers).

This third conference was themed "Partnerships for Grassland Conservation." The suitability of the theme was apparent in the number of presentations on new and established efforts to conserve grasslands and promote rangeland health. It seemed a natural progression of the work of conferences past. However, this event also highlighted the other (dismal) trend of continued grassland loss. Tyler Lark, a plenary speaker, presented staggering numbers, particularly post the passing of the Renewable Fuel Standard, on the extent of conversion in fragile areas such as the Prairie Pothole Region.

While continuing to grapple with issues of grassland loss and the profile of grassland conservation we explored the viability of ranching, sustainable supply chains, landscape level monitoring, grassland dependent species, and of course the diversity of partnerships. As with the previous conference, the focus on working with ranchers continued to be popular and we significantly increased participation of ranchers in 2015. One of the most attended (and hence most over the time allocation) sessions was run by a number of ranchers on their perspectives regarding grassland livelihoods. All this was accompanied by enthusiastic and energizing conversations in a number of roundtables and networking events throughout the conference.

A number of dedicated individuals were critical to the success of this conference including the members of the conference organizing committee, each of the conference moderators, all of the speakers and poster presenters, as well as the many attendees. We sincerely thank the conference sponsors for their generous financial support that expanded our ability to offer subsidized attendance to many and for making the conference possible.

Lekha Knuffman and Aviva Glaser
National Wildlife Federation

Arvind Panjabi
Bird Conservancy of the Rockies

Rick Knight
Colorado State University

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KEYNOTE AND PLENARY SPEAKERS

KEYNOTE ADDRESS

- **Carol Davit, Missouri Prairie Foundation**

PLENARY SPEAKERS

- **Dr. Robin Reid, Colorado State University**
- **Tyler Lark, University of Wisconsin, Madison**
- **Dr. Chip Taylor, Monarch Watch**

OPENING KEYNOTE: GUARDIANS OF FLYOVER COUNTRY

Carol Davit

We convene at this conference from throughout our country's grassland regions, and beyond. Many of you are from the short-grass and mid-grass prairie region, where climate has been the big player in shaping your grassland landscape. Others have come from the Midwest, where I'm from, and farther east, where many tallgrass prairies have competed for space for thousands of years with the eastern deciduous forest, and where fire plays a bigger role than climate in maintaining our native grasslands.

No matter which part of the grassland region we represent, and love, we share concerns common to all grasslands—land conversion, habitat fragmentation, invasive species, wildlife conflict issues, and, what I think is the most difficult of a very long list of challenges: *making grassland conservation relevant to the American public.*

I'd like to share some of my experience with prairie in a place that doesn't always come immediately to mind when you think about America's grasslands: the great Show-Me-State of Missouri. I was one of the luckiest kids in the world. I grew up on the grounds of a nature reserve outside of St. Louis, because my parents lived and worked on the property. It was a childhood filled with exploring creeks, hiking in the woods, and getting impressive numbers of tick bites.

Photo credit: R.S. Kinerson.

As a teenager I had seasonal jobs there, and for at least one summer I worked with my dad, who was establishing 200 acres of a tallgrass prairie planting. It's a wonderful planting that has introduced lots of people around St. Louis to what a real prairie might look like.

Maybe it isn't the case here in the West, but at least for many people in the Midwest, they can grasp the concept that you can't go out and plant a desert, or an Arctic tundra, but for some reason they have this romantic notion that you can go out to a field, throw out a bunch of wildflower seeds, and bingo: Instant Prairie.

Many of you, like my dad, are involved in establishing prairie plantings or reconstructions. My dad would never claim that he was creating a prairie ecosystem—he understood, as, I'm sure all of you habitat restoration professionals do, that you can construct, or reconstruct, a few elements of prairie, and some prairie insects and

birds and other creatures may take up residence there, on their own. But, prairie in Missouri and elsewhere is thousands of years old—you can't do an instant prairie makeover and expect all the parts to be intact.

I was fortunate to go on to work in the field of conservation, and specifically, into my current career of prairie conservation. My job involves explaining what prairie is, and what it isn't to many people who don't have a clue.

They don't realize that we have breathtaking grassland landscapes in the Midwest or amazing plants and animals like this on our prairies. All of the life forms of our native grasslands are from Missouri and other parts of the tallgrass prairie region—not in some far off place on the other side of the world. Several years ago this point was brought home to me in a new way when I was visiting the Berkeley Botanical Garden, which cultivates and displays plants from the world's temperate climates.

When I was there, I admired the monkey puzzle trees from the Andes, the proteas from South Africa, and I gushed over dozens of other plants from faraway places. Then I came to the eastern North American plant collection.

Blooming just a few feet away from those other marvelous plants, I saw western ironweed, collected from my current home of Cole County, Missouri. Asters, coneflowers, prairie dropseed grass, and other plants that grow on Missouri prairies and other parts of the Midwest were on display, getting equal stage time with exotic flora of the world.

But of course, all of these prairie species from the Midwest that I saw are themselves part of the world's exotica, as are grassland species from throughout our continent. Our grasslands have a place in this world, and they are here, not out there, and that alone makes them relevant to our culture, our aesthetic sense, and our economy.

In Missouri, despite the efforts of conservationists like myself, most people don't know about our state's prairie heritage. Why? Because it is very scarce. In fact, we have less than 1/10 of 1% left of its original acreage in the state. Some other states in the tallgrass prairie region have an even smaller percentage remaining.

With such a small amount left, there isn't much prairie around to see in he Midwest as there once was, and when it goes, its loss is not immediately noticed. Unlike giant trees crashing down from a rainforest canopy, prairie doesn't make a lot of noise when it goes.

When prairie is plowed up, and replaced with something else green, the land can look, to some people, when they're driving by at 60 miles per hour, vaguely the same as what was there before.

Like corn and soybean fields. Or tall fescue, a Eurasian grass introduced in the 1950s in Missouri and other parts of the tallgrass prairie region for cattle forage and other uses, and it now covers an estimated 14 million acres of Missouri. That is almost one-third of the state.

Missouri ranks second or third in the nation in cow/calf operations, and tall fescue is important as cool-season forage for cattle, but its pervasiveness is selling short our native biodiversity and the environmental service capacity of our land. So much of our original landscape in Missouri and elsewhere in the tallgrass region has been altered, so much in fact that sometimes it's hard to understand why saving our few, remaining, and often very small, tracts of original prairie would make any difference, and what we would lose if they were gone.

At the time of statehood, there were 15 million acres of prairie in Missouri—about a third of the state. It developed in Missouri about 8,000 years ago, along with forests and other native habitats of the Midwest. Today, we have fewer than 70,000 scattered prairie acres remaining in the state. This is the less than 1/10th of 1%. In Missouri, prairie is the rarest habitat type in the state—and globally, it's more rare than tropical rainforests.

I showed a map of our remaining prairie in Missouri—with the remnants only scattered acres—to someone recently. But I wasn't prepared for her response. She looked at it and said "But—there's nothing there! It's like a joke!" As if "Why bother?"

After I pulled the knife out of my heart, I thought about why she would say that. Ok, they look like specks. But, to us in the Midwest, they aren't a joke. We fight to save them, because we know that original prairies can never be recreated. We know that they are, as a prairie enthusiast in Iowa stated so well, "part of the original fabric of the world."

"We are the guardians of this magnificent swath of the continent. Our grassland region is not something to be merely flown over."

In Missouri, our remaining prairies are mostly in the southwestern part of the state, where rocky ground has spared some parcels from the plow. These are patches of a few thousand, a few hundred, or even a few dozen acres. And unless we act swiftly, there's no guarantee that we won't lose many of these.

Tallgrass prairie remnants—and the larger grassland landscapes here in the West—have inherent value—they don't have to prove their worth. But they do provide us with direct benefits—if we recognize the monetary value of their services to us of carbon storage, water filtration, pollination services, sources of seed for grassland reconstruction projects and native pastures, and other measurable benefits, many of which we will learn about today and tomorrow at this conference.

We are also on the cusp of new applications of prairie plants and soil. For instance, in northeastern Missouri, a project is underway to convert thousands of acres of degraded farmland into plantings of diverse native grasses and forbs. The biomass harvested from these plantings will be converted to compressed natural gas. And while some above-ground plant material will be turned into energy, other vegetation will be left for wildlife habitat, and all the while, the roots, of course, will continue to capture carbon and prevent erosion. This project is spearheaded by Rudi Roeslein, a Missouri Prairie Foundation supporter who spoke about this project at the last America's Grasslands conference.

We know that prairie root systems support *the most diverse soil microbial communities on earth,* largely due to continuous inputs of organic substances. Soil scientists at the University of Missouri and elsewhere are using genomics to gather new information about prairie soil microbes—about their role in nutrient cycling and other activities—and this new information is being studied for its application to agriculture, with the hope that what is learned would actually decrease the use of synthetic chemicals in agriculture. And yet, even as new technologies are exploring new uses of prairie, and even as our grassland landscape continues to be fragmented, there's still so much more basic, baseline information to collect. In Missouri and elsewhere, new scientific data are gathered from our prairie remnants every year, despite their small size, despite the fact that ecologists have determined that prairie is one of the *least conserved, most threatened* major terrestrial ecosystems on earth.

This past summer, a colleague of mine, the botanist Justin Thomas, was surveying one of the Missouri Prairie Foundation's smallest remnants—a 37-acre original prairie in southwestern Missouri. Justin discovered a record number of 38 native plant species growing in a quarter meter random sample plot. Many of these plants will grow nowhere else in the world but on original, unplowed prairie. The average number of plant species in a quarter meter of a Missouri forest, for comparison, is 7.

In an area of original prairie about the size of the seat of the chair you're sitting in, Thomas found 38 species, the highest number of plant species he has ever found in Missouri at this scale. That quarter meter of prairie contained sensitive briar, Mead's sedge, grooved yellow flax – and 35 other plant species.

On this same 37 acres, this past June, lepidopterists, found this cryptic olivaceous phaneta moth. Goldenrod is its host plant. It hasn't been documented in our state in 120 years, yet it continues to exist, on 37 acres of original prairie, and, I hope, elsewhere. On another of our organization's original remnants—a 171-acre prairie—lepidopterists found more than 65 species of moths in only few hours of collecting.

This kind of biological diversity is simply not possible to replicate in a planting. Even in a prairie reconstruction started in the 1940s in Madison, Wisconsin, biologists there are still not seeing the species richness of plants or animals that can found in original prairie. Last year, Mike Arduser, who is a bee biologist from St. Louis, surveyed an 8-acre tract of land in Joplin, MO that the Missouri Prairie Foundation purchased in 2014. On these 8 acres is a ¾ acre prairie remnant. On this tiny remnant, Mike found Andrena beamerii, a native bee species that forages on *Coreopsis* pollen, a species that most bee specialists have never even seen. In fact, the male has not yet been described by science. As Mike has said, "While a few acres of habitat may be just a corner park to us, for some bees and other insects, it's their entire world."

And if we drill down, to a microscopic level, there is still much more baseline data to collect about the things we can't see, in prairie soil. Two years ago soil scientists from here in Colorado, at the University of Colorado in Boulder, published some amazing news. These scientists had found abundant bacteria in the soil of unplowed prairie from an entire phylum of bacteria that *is not present in tilled fields* that were once prairie. In 2013 the *New York Times* editorial board wrote, "Finding these bacteria is like finding a piece of a lost continent."

Our remaining prairies throughout the grassland region are vestiges of one of the mightiest ecosystems ever to grace the earth. Our prairie soils and grazing lands made North America into an agricultural powerhouse like nowhere else in the world. And what remain may be called remnants, but they are not artifacts, they are teeming with life—living laboratories of generic resources that we cannot afford to lose. They are perhaps all the more precious because they are so scarce and so vulnerable.
In addition to the tangible gifts they give to us, our American grasslands help define us, make us different, give us confidence *to defy, in fact, the concept of flyover country.*

As the American poet Walt Whitman wrote in 1879, ". . . while I know the standard claim is that Yosemite, Niagara Falls, the Upper Yellowstone and the like afford the greatest natural shows, I am not so sure but the prairies and plains, while less stunning at first sight, last longer, fill the esthetic sense fuller, precede all the rest, and make North America's characteristic landscape."

We are the keepers of this landscape. The keepers are us, the grassland professionals, and they are also the ranchers and hay producers—who have saved many of our native grasslands from being converted to something else—and the keepers are hunters, who have advocated for the protection of game habitat, upheld our hunting heritage, and are moving it forward into the future.

It is up to us to make our American grasslands relevant. When I say us, I mean the soil scientists, ranchers, biologists, birders, restorationists, hunters, photographers. I mean the botanists and the moth experts, the planters of milkweed, the stargazers who seek our prairies' dark skies.

We are the proponents of a new kind of economy, which calculates the true worth of grasslands, their species, and their services to us. We must continue to involve and engage bioengineers, hydrologists, economists, and other allies in the development of the carbon market, native bioenergy production, and water quality services.

We are the guardians of this magnificent swath of the continent. Our grassland region is not something to be merely flown over. It is not to be discounted from the window of an airplane. Our grasslands are not in the way of getting to somewhere, or to something else. Our grasslands are our center.

Let's learn all we can these two days we have together, listen carefully, ask questions, share stories and advice, keep open minds to new ideas, and above all, after we leave this conference, for the sake of our grasslands, keep our heads held high. Thank you.

GRASSLAND CONVERSION ACROSS THE UNITED STATES: CURRENT STATUS, IMPACTS, AND POLICY IMPLICATIONS

Tyler J. Lark, University of Wisconsin-Madison

Other authors: Holly Gibbs, University of Wisconsin-Madison

The United States has entered a new era of agriculture, defined by revised federal policies, changes to commodity markets, and increased demand for crops for uses like fuel. These drivers have led to changes in our nation's landscape as well as emerging threats and opportunities for grassland conservation.

Currently, there are about 400 million acres of grasslands remaining in the United States—equal to roughly half the country's original grassland extent prior to European settlement and the expansion of cultivated agriculture. Thus, looking at the combined area of both grasslands and croplands can give insights into the total area grasslands once occupied across America (Figure 1). This ongoing dynamic—the conversion between grasslands and croplands—remains a key issue for grassland conservation today, as conversion to crop production still remains the number one threat to grassland loss, responsible for about 5x as much annual conversion as urban expansion or development.

To better understand this dynamic, we tracked recent agricultural land-use change across the conterminous United States from 2008-2012. We found widespread transformation of grasslands to cropland, including significant conversion of long-term undisturbed grasslands that had not been cultivated for over 4 decades. In total, over 6 million acres of grasslands—an area the size of Maryland—were converted to crop production 2008-20121. This conversion has substantial implications for wildlife and biodiversity, soil and water quality, and net carbon sequestration.

For example, most new croplands were on marginal land defined as having severe to very severe limitations to cultivation, whereas the majority of pre-existing crop extent was located on prime agricultural land well suited to cultivation (figure 2). Furthermore, the percent of new croplands planted on land deemed unsuitable for cultivation was twice as high as that for pre-existing croplands. As a result, new croplands are likely to generate greater erosion and soil loss, as well as lower yields due to the lower agricultural suitability of this land. In addition, overall indemnity costs of the crop insurance program could rise since crops are being planted in increasingly less suitable and higher risk areas.

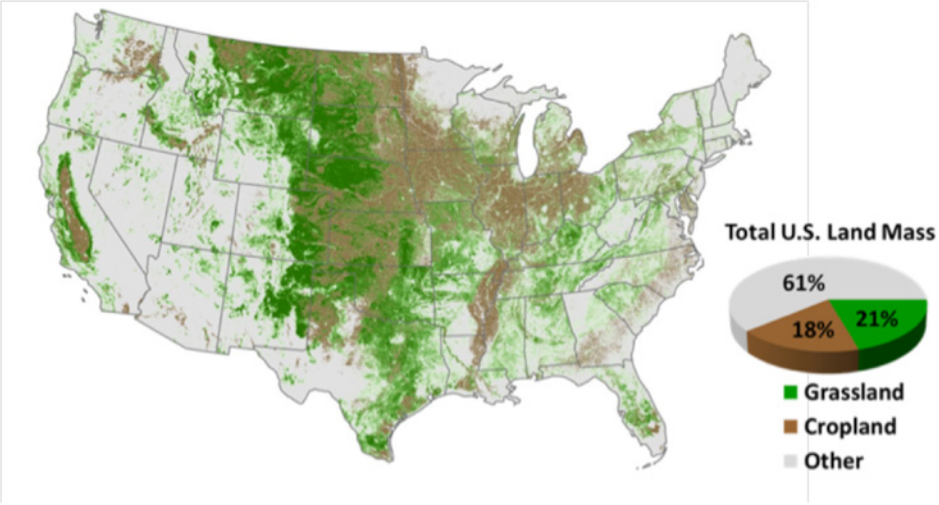

Figure 1: Current U.S. grassland and cropland extent, circa 2014.

The recent changes to the U.S. landscape also reveal opportunities to improve conservation through federal policies, particularly in the U.S. Farm Bill and the U.S. Renewable Fuels Standard. The Sodsaver provision of the 2014 Farm Bill aims to reduce cropland expansion into previously-uncultivated areas by reducing the crop insurance premium subsidies on land converted from native sod. However, we found 2/3rds of conversion from previously-uncultivated land occurred outside the 6 states protected by Sodsaver in the 2014 Farm Bill's implementation. This provides strong evidence that if the Sodsaver policy is to achieve its goal of reducing the cultivation of native sod, nationwide coverage and implementation is needed.

We also found that the current enforcement mechanism of the Renewable Fuels Standard—known as "aggregate compliance"—may be problematic. By law, land eligible for renewable feedstock production under the RFS must have been already "cleared or cultivated" by December 20073; however, the current aggregate compliance monitoring mechanism is unable to detect fine-scale land conversions that occur across the landscape after this date. Thus, the Renewable Fuel Standard may currently be permitting, rather than preventing, the conversion of grasslands.

In summary, our findings show that recent conversion of grasslands is a nationwide phenomenon, and that aggregate measures of cropland expansion and grassland loss do not capture all the changes that are occurring on the ground. Rather, spatially-explicit assessments of gross land-use changes are needed. We've also seen that conversion from grasslands to croplands is occurring in less suitable areas, with significant costs to the environment. Fortunately, closing the gaps in our existing policies may provide effective solutions. In particular, expanding Sodsaver and improving enforcement of the RFS could help protect grasslands while also facilitating more climate-smart approaches to agriculture and bioenergy goals.

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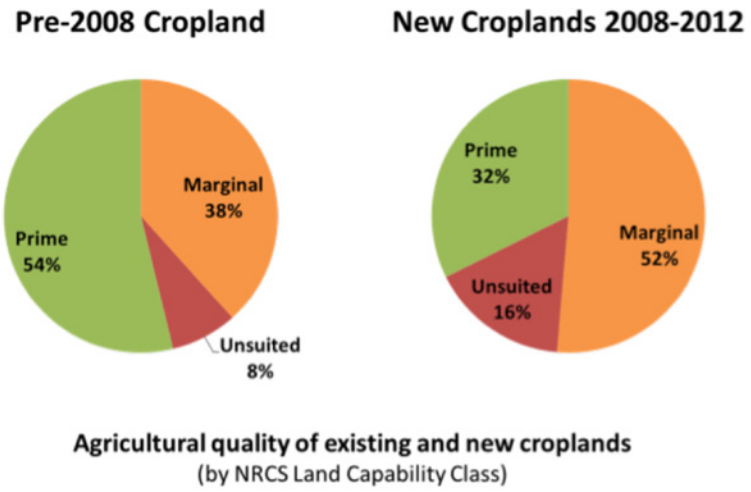

Figure 2: Agricultural suitability of pre-existing and new croplands. New croplands are more likely to be on less suitable land.

1. TRACKING THE STATUS AND CONVERSION OF GRASSLANDS

CHARACTERIZING LAND USE CHANGES IN THE DAKOTAS USING HISTORICAL SATELLITE SENSOR DATA: 1984-2015

Gaurav Arora, Iowa State University

Other Authors: Peter T. Wolter, Iowa State University; Hongli Feng and David A. Hennessy, Michigan State University

Recent research has utilized U.S. Department of Agriculture's Cropland Data Layers (CDL) to provide evidence on transitioning land use in the U.S. Western Corn Belt (WCB) (Wright and Wimberly 2013, Johnston 2014). The westward expansion of the WCB has garnered much attention over the past decade. An important concern is that the expanding corn and soybean areas are replacing traditionally native grasslands in the Prairie Pothole Region. The region's remaining grasslands are of great value since they support biodiversity by sustaining waterfowl nesting habitats and helping to conserve prairie ecosystems. However, these valuable natural resources have been subjected to rapid conversions for use in crop agriculture. High commodity prices, agricultural risk management policies, technological innovations and climate change are possible drivers of land use change. In order to study how these changes correlate with possible causal factors we need robust spatial and temporal measures of land use change in the area.

Our research goal is to better document land use changes in North and South Dakota east of the Missouri River during the 1984-2014 time interval. Recent studies have utilized CDL's products for detailed characterizations of Dakota's transitioning land use. Using the high-resolution CDL-based spatially delineated products brings strength to such analyses as they identify transitions among various land use types and their locations. As an example, Wright and Wimberly (2013) identified both grass to corn/soy and corn/soy to grass transitions to conclude that a net of 271,000 ha grasslands were lost to corn/soy production in the eastern Dakotas between 2006 and 2011. Moreover, their study provided visual heat maps to represent rate of conversion in each transitioning categories at a spatial resolution of 56-meter pixels. Such an analysis offers a better understanding of the factors that could be driving land use changes in the Dakotas, when contrasted with the aggregate county-level data. Hence, the CDL products have added a long-needed spatial dimension to the analyses concerning characterization of land-use change.

However, CDL products are constrained due to a narrow window of data availability, 2006-2014 for South Dakota and 1997-2014 for North Dakota. This is problematic for formal analyses that seek to identify the drivers of land use change. For instance, agricultural policy, climate and the state of infrastructure change incrementally, necessitating a longer time-series of data for robust inference on their impacts on land-use change. To facilitate such inference, we utilize historical, 30-meter, satellite sensor data for 1984 and later, to better quantify the onset of land use change leading up to the first years of the CDL archive.

We design and implement a robust satellite image processing algorithm to identify historical land uses in the Dakotas since 1984. We quantify corn, soybeans, wheat, alfalfa, and grass areas using multi-spectral visible and infrared reflectance information recorded by the Landsat Thematic Mapper (TM) sensor. We implement our algorithm on the raw Landsat imagery acquired from the U.S. Geological Survey's online archive **(http://earthexplorer.usgs.gov/)** that dates back to 1984, as do our land use characterizations.

These archived Landsat image products are corrected for terrain and atmospheric effects and contain a cloud mask. We utilize this mask to replace an image's excessive cloud cover with alternative imagery acquired from the Landsat sensor's adjoining paths to the west or east, as there is substantial side lap at the latitude of our study area (ca. 70%).

Our algorithm utilizes each crop's unique phenology that determines the best times of year for its identification. Imagery dating from late-July to mid-August were found to best characterize corn while imagery acquired in late-September (22nd-30th) best characterized soybeans, wheat, alfalfa and grass. We use visual cross-validations to verify our algorithm's characterizations against the existing CDL products. The usable window for September imagery is narrow as the repeat frequency of the Landsat sensor is 16 days. Further, wheat and alfalfa area was found to be erroneous when using imagery from outside of the time window described above. We used the National Land Cover Database's 2006 product to clip out the incorrectly characterized development areas, open waters, shrubs, forests and wetlands.

The figure below shows the TM sensor's path coverage provided by Landsat in the eastern Dakotas. We present land use trends for eastern South Dakota (within the red squares in figure 1) in a table. We find that the absolute area under corn increased by 332,012 ha. during 1997-2011 and by 265,359 ha. during 2006-'11. The average annual rate of increase in area under corn seems quite high if we restrict ourselves to the time-series commencing in 2006 (as with CDL for South Dakota). However, our longer time-series of land use data reveals that corn area peaked in 1996 (960,000 ha.), a point that is omitted when using the CDL's shorter time-series. In fact, the average corn area in 1995-'97 (860,452 ha.) is about the same as its area in 2006 (846,351 ha.). We find a similar discrepancy for soybeans when contrasting trends using the shorter time-series of data due to CDL and using the longer time-series due to our algorithm. Overall, we conclude that CDL's narrow window of data availability may provide misleading inferences on the extent and rate of land use change.

We would like to caution our reader about the possible errors in our land use estimates under various categories. Based on cross-validations from NASS's county-level area, we find that our algorithm overstated corn (1993), soybean (1986, 1993) and wheat (1991, 1998) and understated soybean (1998) and wheat (1986, 1993) likely due to variability in specific crop phenology. In the future work, we will perform formal accuracy analysis using field observations. To that extent, ours is a work in progress as we are also in the process of producing land use statistics for Landsat scan path in eastern North Dakota.

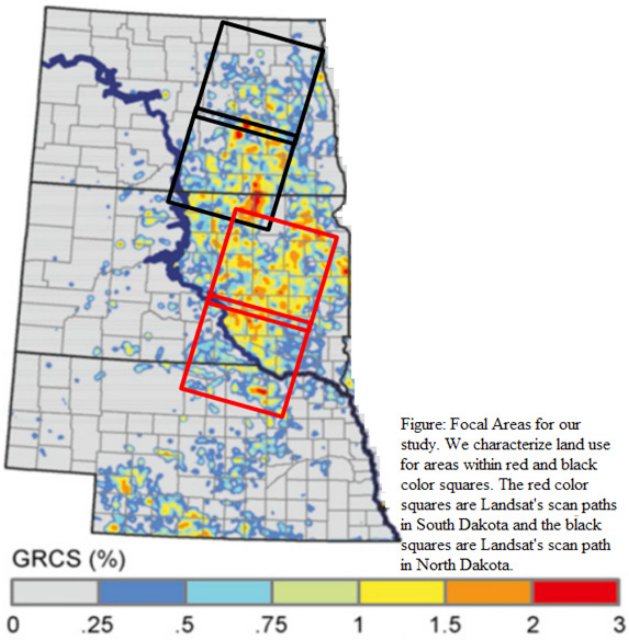

Figure: Focal Areas for our study. We characterize land use for areas within red and black color squares. The red color squares are Landsat's scan paths in South Dakota and the black squares are Landsat's scan path in North Dakota.

Figure 1. Note: This image has been adapted from Wright and Wimberly (2013). The color gradient is used to visualize absolute change from grass to corn/soy categories.

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Table 1: Landsat derived land use areas (in hectares) for eastern South Dakota (1984-2005). CDL-derived areas for 2006 and 2011.

Year	Corn (ha.)	Soybeans (ha.)	Wheat (ha.)	Alfalfa (ha.)	Grass (ha.)
1984	-	102,880	575,190	27,084	3,437,010
1985	554,238	-	-	-	-
1986	-	798,497	239,190	130,646	2,738,590
1987	418,452	119,074	771,051	30,996	3,442,160
1988	304,748	-	-	-	-
1990	653,842	-	-	-	-
1991	464,596	168,959	1,288,180	11,056	2,971,070
1993	1,173,850	911,949	154,325	124,200	2,015,570
1994	-	671,978	261,248	160,538	2,991,280
1995	840,758	-	-	-	-
1996	960,899	-	-	-	-
1997	779,698	744,151	243,190	143,930	2,588,660
1998	-	101,854	636,690	44,554	3,567,530
1999	750,506	-	-	-	-
2001	631,064	-	-	-	-
2004	-	662,943	359,972	136,651	2,927,130
2006	846,351	836,556	370,908	125,980	2,238,460
2011	1,111,710	928,280	247,886	109,391	1,773,240

Notes: Missing values signify unavailability of good raw imagery for land use characterization.

PLOWPRINT: TRACKING CUMULATIVE LOSS OF GRASSLAND TO CROPLAND ACROSS THE NORTHERN GREAT PLAINS AND BEYOND

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The grasslands of North America are being converted to cropland to provide food and fuel to a growing global population. Tracking this loss over time has been the focus of a variety of studies, with most authors directing their attention to where loss is occurring over a specific time period, and attempting to most accurately define which parcels of land are switching land covers. Studies in the United States generally suggest annual loss rates between 1-5% (Classen et al. 2012, Faber et al. 2012, Goldewijk 2001, Lark et al. 2015, Rashford et al. 2011, Wright and Wimberly 2013).

We took a different approach to tracking loss in the Northern Great Plains and Mississippi River Basin, driven by our main goal of identifying remaining intact habitat. Our methodology, which lead to a product that we call the "plowprint", uses the National Agricultural Statistics Service's Cropland Data Layer to track cumulative loss of grassland to cropland over the period from 2008 to present (USDA National Agricultural Statistics Service 2013). We also used a similar methodology to track grassland loss since 2009 in Canada, using the Agriculture and Agri-Food Canada

Annual Crop Inventory data, which allows us to track change across the U.S.-Canada border (Agriculture and Agri-Food Canada 2013). Our methodology uses a rule that allows pixels to be added to the plowprint, but never deleted. Thus, once a pixel has been converted to cropland, that pixel is then considered part of the crop base within the study area. The resulting plowprint, then, shows cumulative loss over time and across space. We subtract this crop base, along with developed lands and open water, from total land cover in the study area to determine remaining intact habitat. Remaining intact habitat, then, is defined as being habitat that has not been plowed since 2008, but could be in non-native cover or potentially plowed before this time period.

As of 2013, the plowprint covered approximately 32% of the total Mississippi River Basin-Great Plains study area (not including open water and developed lands). Our analyses suggest that 1.3 million acres of intact habitat were lost from 2013-2014 within the Northern Great Plains ecoregion, while 2.9 million acres were lost within the Plains and Prairie Potholes Landscape Conservation Cooperative boundary, and 4.0 million acres were lost within the entire study area.
This loss is not occurring at equal rates across the ecoregion, with some counties experiencing higher than average rates of loss, while others see relatively low rates of loss. We are able to track losses by county over time, which can assist us in prioritizing the implementation of Farm Bill programs and other actions on the ground in key geographies. This study represents a useful addition to the literature that tracks the loss of grasslands to row crops during specific time periods by helping to define the "best of what's left" for prioritization by various agencies and groups working in the Great Plains.

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FARMLAND USE DECISIONS AND GRASSLAND CONVERSION IN THE DAKOTAS: 2015 SURVEY AND ANALYSIS

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For many decades, land use change between crop and grass cover has been prominent in the Prairie Pothole regions (PPR) of North and South Dakota.

Since 1985, producers in both states have been major users of the CRP (Conservation Reserve Program) converting millions of cropland acres into grassland habitat. In more recent times, from 2006 to 2011, cropland enrolled in CRP decreased from 5.0 million to 3.8 million acres the Dakotas with most of the post-CRP tracts converted back to cropland use (Feng, Hennessy, and Miao, 2013). During this same time period, there has also been considerable conversion of native grassland and tame grassland to cropland use, especially to corn and soybeans, in the Prairie Pothole region of both states (Wright and Wimberley, 2013; Reitsma et.al. 2014).

Most recent studies of land use conversion have used various federal agricultural and conservation program databases, U.S. Census of agriculture statistics, and satellite remote sensing techniques to estimate land use conversion and cropland use change in both Dakotas. This study uses a Farmland Use Decision survey of producers and landowners in the Dakotas to obtain data on their: (1) recent and projected agricultural land use patterns, (2) land use conversion (grass to crop/ crop to grass), and (3) views on the main drivers of land use change and conversion. The perspectives of agricultural producers is especially important if we wish to understand the dynamics of land use change and the major factors influencing these principal decision makers.

The study region consists of 37 counties in South Dakota and 20 counties in North Dakota located in the Prairie Pothole region (PPR) where: (1) corn, soybeans and wheat are the dominant crops, and (2) considerable land use change and land use conversion has occurred in the past 10 – 20 years. The mail survey was conducted in March and April of 2015. Data collected from 1026 producer respondents (36% response rate) are the basis of this study (Luri, 2015). Respondents provided considerable information on land use change and conversion decisions made in the past 10 years. Key findings are listed below.

1) The average farm size per respondent was 1206 cropland acres and a total of 1686 acres operated. Most of the remaining acres were tame or native grassland. Almost all producers had some cropland, while three-fourths also had some pasture or rangeland.

2) Farmers in the study region operated more acres of cropland compared to 10 years earlier. Nearly 90% of respondent producers raised corn and/or soybeans each year during the past 10 years. Corn and soybean acres have also increased on a majority of the farms in this time period. Nearly half of North Dakota respondents raised wheat each year compared to only 28% in South Dakota. Very few (<5%) respondents in each state increased their wheat acres compared to other crops. Nearly half of respondent producers adopted or increased their use of no-till crop systems.

3) Most producer respondents in both states perceived that grassland acreages within their local area (less than a five mile radius from their farm headquarters) has decreased in the last 10 years, while corn and soybean acres have increased.

4) During the past 10 years, the grass to crop conversion rates (as percent of 2014 cropland acres) was 7.2% in both states, with more CRP grass conversion in North Dakota and more tame / native grass conversion in South Dakota. Grassland to cropland conversion is more common in the central regions of both States, compared to the eastern regions. Most of the converted grassland was planted to corn or soybeans.

5) There is also some conversion from crop to grass, primarily related to new CRP or WRP (Wetland Reserve Program) enrollment or post-CRP land use remaining in grass for hay, grazing or wildlife habitat. Most of the crop to grass conversion is also occurring in the central regions of both states. Overall, the net conversion rate of grassland to cropland was 4.9% of 2014 cropland acres.

6) Overall, forty percent of respondents had converted some grassland to cropland use in the past 10 years, with converted grassland averaging 13 – 14% of their 2014 cropland aces. Based on survey results, land use conversion decisions in the study regions were more likely made by respondents with the following characteristics: 1) those that expanded their land

operation, in terms of acres operated during the past 10 years, 2) those that currently operate more than 2000 acres and have gross farm sales exceeding $500,000, and 3) those who are currently less than 50 years old. Grass to crop land use conversion decisions were much less likely to have been made by operators of smaller size farms, by farmers more than 60 years old, and by those farmers who had downsized their operation, in terms of acres operated, in the past 10 years.

7) Comparatively few producers have plans to convert land use from grass to crop use or from crop to grass use in the next 10 years. For example, very few respondents (only 2.6%) plan to convert some native grassland to cropland use and only 6.5% plan to convert tame grassland to cropland use in the next 10 years. Finally, about one-eighth (12.6%) of respondents have plans to convert some cropland to pasture or grassland in the next 10 years.

Respondents were asked to rank the relative importance of 10 different driving forces that affected their land use decisions, especially land use changes, in the past 10 years. Most of the driving forces can be grouped into economic, technology change, policy and environmental factors (table 1).

1) Changing crop prices was the most important driving force influencing land use decisions. One-half of all respondents indicated increased crop prices was the single most important factor behind their land use decisions, especially conversion decisions.

2) Changing input prices (for seed, fertilizer, chemicals etc.) and increased crop yields (for reasons other than seed traits) were the second and third most influential impact factors. These two factors were selected by a total of 26% of all respondents.

3) Changing weather / climate ranked 4th in terms of percent of respondents selecting this item as their most influential decision factor. However, only 6.9% of respondents selected this item as their most important decision factor. Based on respondent comments, this factor may reflect the extent to which some farmers encountered flood or drought issues.

4) More efficient crop equipment, pest management practices and crop insurance factors were the next items listed. The other factors in the list including labor availability problems, availability of drought tolerant seed, and improving wildlife habitat were not often ranked as important in most of their land use decision making. An exception is that "improving wildlife habitat" was ranked high by those converting some cropland tracts to wildlife compatible uses of crops, grass and shrubs.

Table 1: Ranking farm related decision factors affecting land use changes

Farm related decision factor:	Rank	% of respondents listing item as "most important"
Changing crop prices	1st	50.3% of responses
Changing input prices (seed, fert., chem)	2nd	15.2%
Improved crop yields	3rd	10.8%
Changing weather / climate	4th	6.9%
More efficient crop equipment	5th	5.9%
Crop & revenue insurance	6th	3.7%
Pest management practices	7th	2.9%
Labor availability problems	8th	2.6%
Improving wildlife habitat	9th	1.9%
Availability of drought-tolerant seed	10th	1.8%

Overall, the main results from this 2015 producer survey highlight the widespread extent of producer participation in both changing land use patterns and land conversion occurring in the PPR. The other highlight is the importance of economic and technology factors on producer decisions concerning land use and land conversion.

Acknowledgements

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THE UTILITY OF THE CROPLAND DATA LAYER FOR MONITORING US GRASSLAND EXTENT

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For several years the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) has been annually producing a land cover classification focused on identifying crop types across the entire US. This freely available product, coined the Cropland Data Layer (CDL), is derived from Landsat and Landsat-like data and disseminated currently at a 30 meter spatial resolution. The CDL primarily leverages administrative input data from the USDA Farm Service Agency (FSA) for training but also maps non-crop types by utilizing information from the National Land Cover Dataset (NLCD) to help identify covers like forest, urban, and herbaceous areas.

These non-cropland mapping efforts by NASS have been met with keen interest by the broader land cover community, particularly in terms of trying to document grassland areas and changes to its extent. There has been much peer-reviewed literature (e.g. Li et al. 2012; Wright and Wimberly 2013; Johnston 2014; Sahajpal et al. 2014; Lark et al. 2015) written in the past few years discussing grassland conversions and cropland expansion into marginal lands, and is particularly acute given there being no other published statistics available with such geographic resolve or timeliness. However, the CDL has difficulty characterizing accuracy as it relates to non-crop cover types, and in particular grasslands.

And thus in turn, it is not clear the true utility of the CDL for grassland extent monitoring or the robustness of the recent results that have been brought forth by academic and industry groups. So ultimately, the

purpose of this presentation is several fold: 1) to give a brief overview of the history and methodology behind the CDL, 2) to summarize the accuracy and utility of the herbaceous cover types that consist of hay, pasture, and grasslands, 3) to describe what step NASS has undertaken to improve its grassland categories, 4) to elicit feedback from the grassland community to improve CDL characterizations of grasslands, and 5) to seek potential grassland partners in the mapping efforts.

NASS research into the use of satellite imagery was originally conceived back in the 1980s and developed for mapping and estimating the areal extent of US dominant commodity crops like corn, soybeans, wheat, rice, cotton etc. That work became pseudo-operational in the middle 1990s with the first public product, coined the CDL, made available in 1997. It however only encompassed the state of North Dakota and was not particularly timely. With the advent through the years of increased computational power, improved methodologies, low and no cost satellite imagery, and cumulative expertise, the program geographically expanded annually to where by 2006 it encompassed the combined agriculturally intensive areas of the Corn Belt, Great Plains, and Mississippi River "Delta." The US was finally mapped in entirety starting in 2009 (Johnson and Mueller 2010) and furthermore, 2008 was completed retrospectively so through 2014 there are seven complete epochs.

The CDLs are derived through supervised classification of multispectral satellite imagery using a decision tree methodology (Boryan et. al. 2011). All of the contemporary CDL products rely on a sample of field-level administrative data obtained confidentially from the FSA. This information is rich in identifying examples of field-level crop types but gives little information on non-agricultural lands. So, to categorize those areas, a proportional sample of non-agricultural ground truth is taken from the NLCD (Fry et al. 2011). The NLCD non-agricultural classes are ultimately integrated alongside the FSA agricultural ones within the final CDL product.

Inter-year methodological differences of CDLs are important to note, particularly to users studying land cover change. First, the classifications prior to 2006 used neither FSA nor NLCD information and were reliant on a vastly more limited set of ground truth data collected solely by NASS. Second, the classification technique was different prior to 2006 in having utilized a maximum likelihood methodology instead. Thus combined, there can be more pronounced differences in the look of the product going from 2005 to 2006 versus other year-to-years. Also, the 2011 to 2014 CDLs used the 2006 NLCD for input while the 2006 to 2010 used the 2001 version, and therefore non-agricultural categories can look more different from 2010 to 2011.

Multispectral satellite imagery used in the classifications has also varied throughout the years a function of availability and cost. Most continuous has been that provided from Landsat 5 Thematic Mapper (TM) having a ground sample resolution, or pixel size, of 30 m, but in the mid-2000s as switch was made to Advanced Wide-Field Sensor (AWiFS) from Resourcesat-1. AWiFS was coarser at 56 m but had advantage over TM in that the imaging swath width was four times wider effectively reducing the revisit rate from 16 days to less than five. Thus, the temporal aspect was improved immensely helped imaging capacity in cloudy and dynamic crop areas. In 2009 TM data became free and was reintegrated in the CDL production alongside the AWiFS. A switch was made in 2010 from AWiFS to the Disaster Monitoring Constellation (DMC) Diemos-1 and UK-2 satellites which also were wide swath but had improved resolution of 22 m. In 2012 only DMC imagery was used due Landsat 5 end of life. Finally, in 2013 Landsat 8 was launched and that data was integrated alongside the DMC imagery.

Thematic accuracy of the dominant crop categories in the CDLs tend to be very high and are routinely above 90%. Average accuracy for all row crops combined tend to be about 80%, while overall accuracies for all cover types including non-agricultural are estimated to be 75% or less. Much of the decrease in overall accuracy versus the crop specific accuracy has to do with the intermixing of the differing forage or pasture grass types which ultimately have accuracies only around

50%. On average the CDLs tends to underestimate crop areas from pixel counting alone (Johnson 2013), but this is not necessarily consistent by crop, region, or year.

The CDLs are used internally by NASS to derived planted acreage statistics for the major commodity crops. There is less concern by NASS to the classification accuracy outcome of the non-agricultural categories because area estimates for pasture and grassland areas are not undertaken. It is important to note that NASS does not use a pure "pixel counting" methodology to derived its areas statistics from the CDLs but rather an adjustment via a "regression estimator." Regression analysis of land cover products is the recognition that pixel counting alone is likely biased, but by comparing a sample of classified pixel areas versus ground collected information one can then compensate. This adjustment varies by crop type and region.

Considerable effort through the years has been made to try to improve the quality of the low accuracy grassland areas even though outside the CDL's core mission. Unfortunately, by trying to do so an inconsistent blend of ground source information from FSA, NLCD, and NASS has been used from year to year and state to state. The particular categories of alfalfa, non-alfalfa hay, pasture/grass, grassland herbaceous and pasture/hay have all been at the center of the definition mix. Fallow/idle cropland has also been complicit. The inconsistent use of these categories stem from irregularities in the quality and representativeness of those herbaceous cover types gleaned from the ground data per geographical region and year. Figure 1 highlights a subsection of the 2014 CDL and shows an inconsistency of grassland related categories most prominent across the Iowa-Missouri border.

So, any inter-year change analyses, particularly with grasslands, derived from the CDLs need to be approached carefully given the inherent uncertainties.

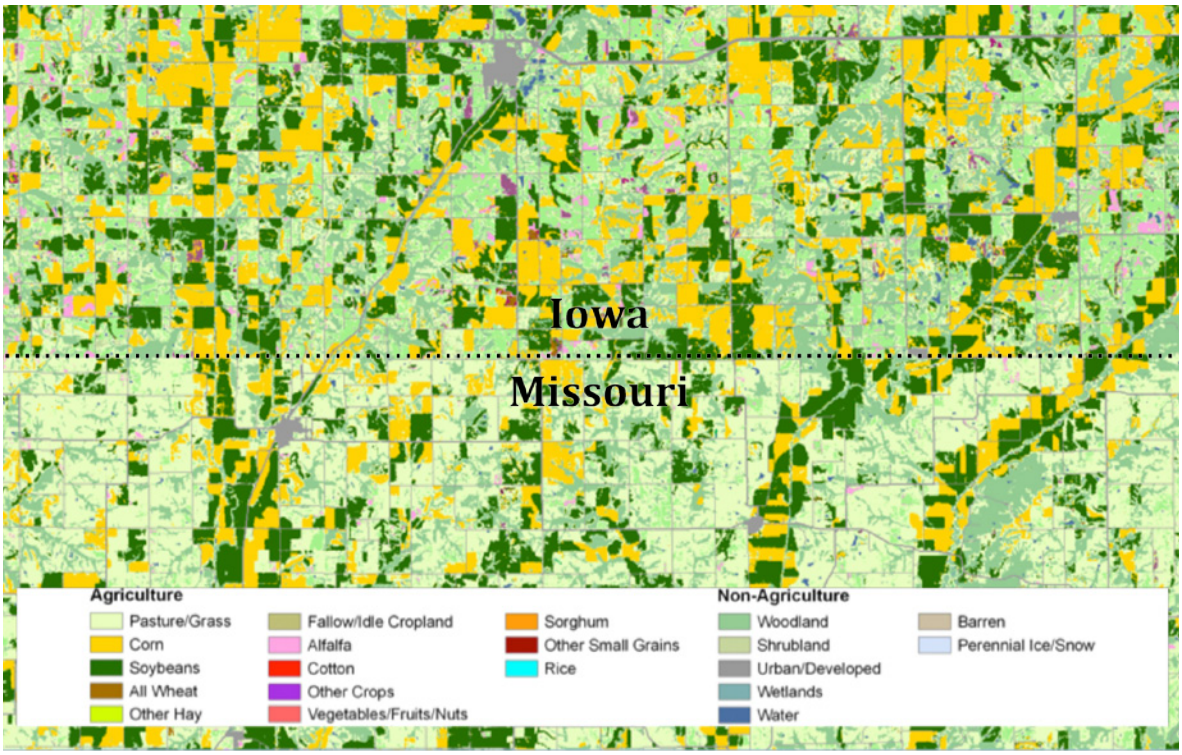

Figure 1. Example 2014 CDL showing across state-line pasture/grass and hay inconsistencies.

Figure 2. Agricultural Data Layer of the conterminous US emphasizing cropland, hay, and grassland areas as derived from the 2010 – 2014 CDLs.

This is particularly true since the bias and noise, within a given CDL classification is likely greater than any actually short-term land cover change. Many techniques including spatial smoothing, application of minimum mapping units, regression analysis, noise reduction, etc. are likely needed at least in part and have been implemented to varying degrees by users. But with a variety of data cleaning approaches available they can, and do, lead to different conclusions about the land cover change.

In response to the various external analyses being done with the CDL data, serious reflection by NASS was put into identifying ways to make a more consistent and improved product in regards to both cropland and grassland related cover types. It was decided, and being reinforced, that the goal of the CDL will remain focused on crop cover types. As such will keep alfalfa and non-alfalfa hay as cropland type categories as they are indeed cultivated and often are rotated, particularly alfalfa, from time to time with row crops. Also, to be strictly defined as a row crop, and not grassland related, is the fallow/idle cropland category. This class is meant to represent fields that are temporarily out of production, usually only for a season, like common in dryland wheat areas of the western Plains.

Grassland/pasture is being established as a new and broader encompassing category. This will be an amalgamation of the grassland/herbaceous and pasture/hay classes of the past but with a clear exclusion of hay areas. NASS is admittedly conceding that it is very difficult to separate herbaceous areas that are not pastured versus those that have at least some degree of livestock on them. The 2015 CDL will incorporate these changes directly during production and promises more consistency, particularly toward grasslands, across state lines.

NASS values the idea of producing an independent high quality "Grassland Data Layer" since the demand for such information seems large and the CDL experience dictates some solid background knowledge. However, the task is a grand challenge and more research and input from a broader community is needed to understand what is feasible to map and what accuracy level is needed to be useful. In the meantime a circa 2014 agricultural layer best depicting cropland,

hay, pasture and grassland layer has been internally developed (Figure 2) based on an aggregation of the 2010 – 2014 CDLs. At this point in time is it the best available at a national-level but it is acknowledged there are still some across state line discrepancies, and it provides no temporal component.

The need for timely, accurate and useful land cover information is very important for being able to best understand and inform land management practice for grasslands or otherwise. Land cover mapping is a challenge and unfortunately as a result there remains a relatively limited set of robust, consistent and spatially explicate information. The annually produced CDL is seen a one component to help the land cover community better understand and be able to answer their questions particularly in regards to the change in cropland and grassland areas but needs to be incorporated thoughtfully. NASS plans annual updates of the CDL product and believes future products will continue to see incremental improvements.

The NASS CDL land cover data is freely available for analysis and download at CropScape: **http://nassgeodata.gmu.edu/CropScape/**. Metadata along with accuracy assessment information can be found at **http://www.nass.usda.gov/research/Cropland/metadata/meta.htm .**

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USING TIME SERIES NDVI TO MONITOR GRASSLAND PHENOLOGY AND CHARACTERISTICS IN MONTANA

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Temperate grasslands are the most threatened large scale ecosystem on the planet. Complicating matters, the conservation status of grasslands can be difficult to determine across landscapes since they range from

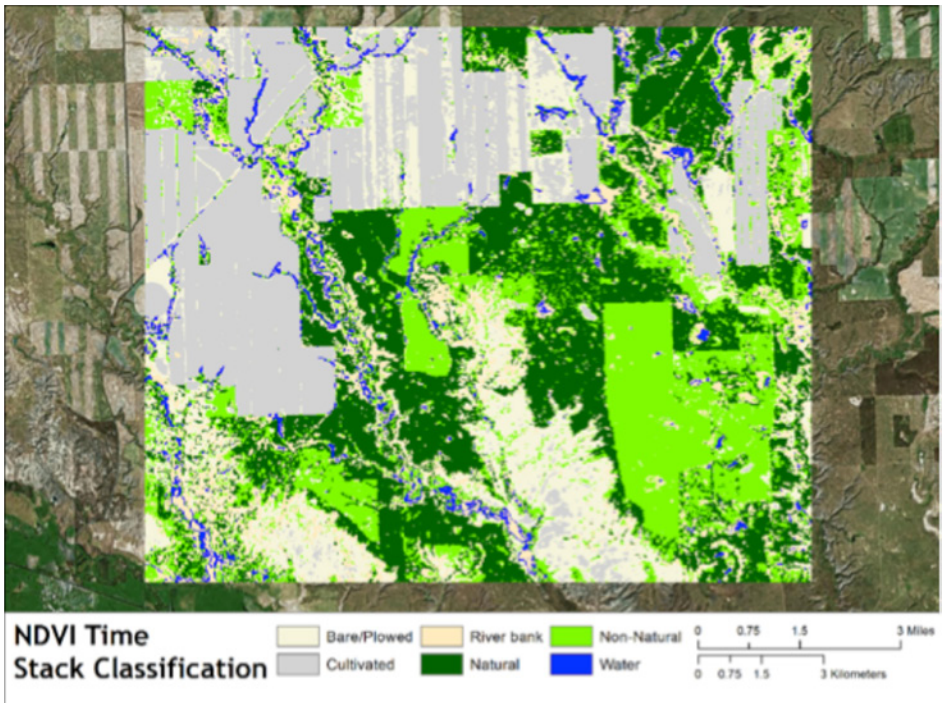

Figure 1. NDVI Time Stack Classification results for Study Area #1. ISODATA cluster analysis resulted in 63 clusters in six land cover categories: Bare/Plowed, Cultivated, Floodplain, Natural, Non-natural, and Water. The unsupervised classification technique resulted in 81% overall classification accuracy within this study area.

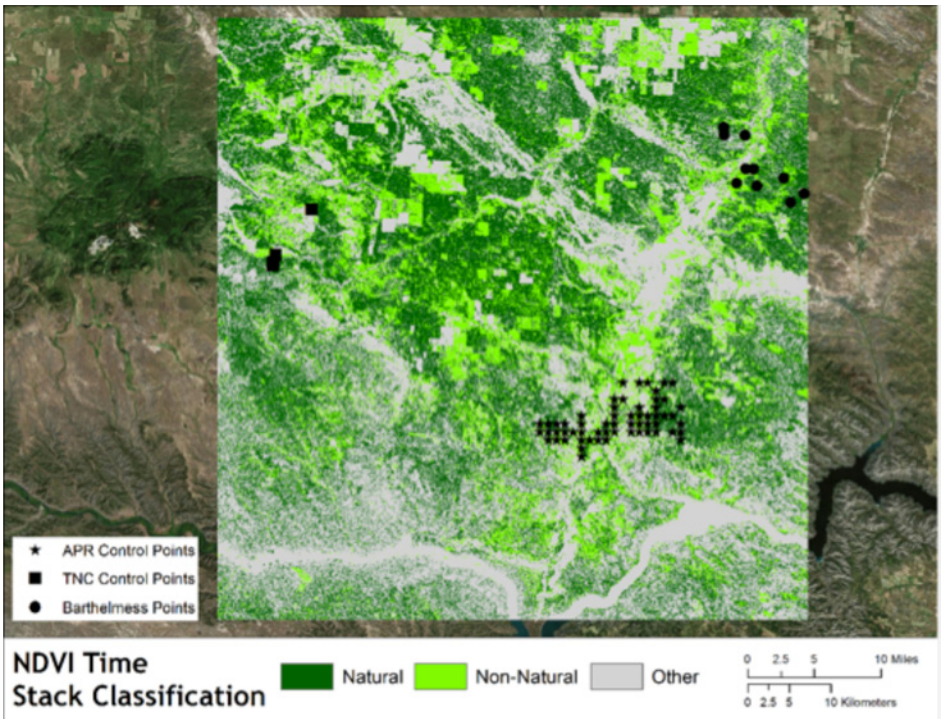

Figure 2. NDVI Time Stack Classification results for Study Area #2. ISODATA cluster analysis resulted in 98 clusters in seven land cover categories: Bare/Plowed, Cultivated, Floodplain, Natural, Non-natural, Scrub and Water. Classification Assessment control points are shown from American Prairie Reserve (APR), The Nature Conservancy Matador Ranch (TNC), and Barthelmess Ranch (private ranch). Overall classification accuracy for this study area was 66%.

natural and semi-natural to completely non-natural species compositions. Remote sensing with traditional spectral analysis has been difficult given physiognomic constraints in the structure of herbaceous vegetation - grass and forb canopy is not as easy to observe from satellite imagery as trees. However, temporal resolution may present an alternative pathway to monitoring change and species composition across grassland landscapes.

Our analyses show that stacking Normalized Difference Vegetation Index (NDVI) layers across a growing season and running an unsupervised classification can differentiate between natural and non-natural grasslands in the Northwest Glaciated Plains subecoregion of northeastern Montana. Our unsupervised classification classified grassland cover with 81% accuracy within our 200 km2 study area (Figure 1) and 67% accuracy in our secondary study area (Figure 2).

Our methods worked well for our study areas and likely could be replicated in the surrounding area of similar climate and latitude. Much work has already been done to monitor grassland ecosystem performance with various vegetation indices, and we feel these should be investigated for other areas. The precise remote sensing software used for the unsupervised classification also is open to further experimentation. The time series image stack, however, is a novel new method that could provide an important link to successfully monitoring grassland ecosystem performance.

MAPPING THE POTENTIAL FOR FIRE INDUCED TRANSITIONS OF TALLGRASS PRAIRIE TO SHRUBLAND AND WOODLAND: ARE WE NEAR A TIPPING POINT?

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A growing body of evidence suggests that many grasslands have fire, grazing, and climate thresholds that, when crossed, can result in difficult-to-reverse transitions to desert or woodland states. This study determines the susceptibility of one of the largest remaining landscapes of tallgrass prairie—the Flint Hills—to shrubland and woodland transitions (i.e. woody encroachment), resulting from changes in prescribed burn frequency. The study uses: (1) knowledge of fire frequency thresholds and (2) a 12-years of satellite data-product that estimating the occurrence of grassland fires ~27,000 km2 area. Specifically, ground-based data suggest that spring-burning every 1 to 3 years is likely to maintain tallgrass prairie, whereas interfere intervals >3 years often results in transitions to shrublands and intervals >10 years often result in woodland transitions (i.e. Eastern Red Cedar). The satellite data suggest that 56% of this landscape is burned less often than every 3 years, making this large area susceptible transitions to shrubland or woodland. These transitions can cause more high-risk woodland fires, reduced grazing potential, and increased abundance of woodland adapted species at the expense of native grassland biota. In the areas likely to remain grassland, at least half are burned annually, contributing to ecological homogenization and air quality issues. While this synthesis forecasts a precarious future for tallgrass prairie grazing productivity and conservation, transitions from tallgrass prairie to shrubland and woodland typically take at least as 20 to 30 years, leaving a small window of opportunity to return fire to the landscape and avoid large-scale transformation of tallgrass prairie. However, the expansion of energy extraction, suburban development, and woodlands could further increases risks associated with burning, creating a cross-current in the effort to increase prescribed burning.

WORKING TOWARDS A "NATIVES FIRST" POLICY FOR USDA CONSERVATION PROGRAMS

Jef Hodges, National Bobwhite Conservation Initiative

For those unfamiliar with the National Bobwhite Conservation Initiative (NBCI), it is an initiative of 25 states representing the core of bobwhite range, academic partners and non-governmental

organizations (NGO's). Representatives from these 25 states fish and game agencies and partners make up the National Bobwhite Technical Committee (NBTC) who developed the NBCI. Each of the 25 states contribute finances to NBCI to support its operation. Some states contribute through P-R funds and other states through other sources. Key NBCI strategies are reconnecting croplands, cattle, forests and people with bobwhites. A few NBCI products you may be familiar with are the CRP CP33 Habitat Buffers for Upland Birds, which also recently included the addition of pivot corners, the addition of the CRP CP36 longleaf pine practice and recent establishment of the Shortleaf Pine Initiative. The NBCI is headquartered at the University of Tennessee's Institute of Agriculture in the Department of Forestry, Wildlife and Fisheries. The NBCI has 7 staff positions, Director, Assistant Director/ Science Coordinator, Data Analysist, Communications Coordinator, Ag Policy Coordinator, Forestry Coordinator and Grassland Coordinator.

The first question to be asked is, "Why a "Natives First" policy targeted at USDA?" USDA subsidized loss and degradation of grassland habitats and establishment of non-native pasture and rangeland continues to impede progress toward a net gain of suitable habitats. USDA programs impact millions of acres annually with many of those acres planted to introduced species with little or no value to wildlife. With respect to NRCS, net gains of native grassland habitat on working croplands and forage lands (pasture and rangeland) is impeded by ongoing technical and financial assistance that fosters spread of introduced grasses (and in some cases aggressive) on forage lands, in soil and water conservation practices on croplands and to some degree CRP enrollments. There is a preferential choice for non-natives throughout much of the eastern and southeastern US and some practices in western rangelands allow planting of up to 25% non-natives in mixed plantings.

The concept is simple, borrowing from the North American Waterfowl Management Plan; end or minimize losses and degradation (no net loss) and accelerate restoration gains. The objective is to implement a national USDA policy that establishes a default preference for native plants wherever feasible in all USDA programs, technical assistance, practices, cost-share and other financial assistance.

What might a "Natives First" policy look like? At this point we have outlined some broad overarching guidelines for the development of the policy proposal but lack any of the details. They are: Place no regulatory restrictions upon private landowners; Cease providing financial assistance for aggressive introduced plants; Promote adoption and use of native plants for most purposes; and Allow flexibility for limited subsidizing of non-aggressive introduced plants.

The strategy for developing the policy proposal is: To form a working group representing stakeholder segments to develop the policy proposal; Build a coalition of groups for support; Enlist promotional support of coalition members; and Have the coalition advance the policy proposal at the appropriate time.

The desired outcomes for this policy proposal and coalition supported promotion is to have USDA enact a policy in which native species are the default first option provided to landowners, does not subsidize aggressive non-native species, establish national ranking criteria that highly favors native vegetation, and Develop and promote a native vegetation initiative with education, technical and resource components.

PRAIRIE POTHOLE POLITICS: CONSERVING GRASSLANDS THOUGH PUBLIC POLICY

Eric Lindstrom, Ducks Unlimited

The Prairie Pothole Region (PPR) is one of the most globally-unique and threatened grassland ecosystems in the world. This region supports significant populations of continental waterfowl breeding populations and many other wildlife species. However, intensive land-use pressures, economic drivers and public policies threaten this region's rare and important grassland habitat.

Diverse, highly-functional grasslands are the cornerstone of this region's robust livestock, pollinator and outdoor recreation industries. These natural assets provide economic diversity and stability to rural communities. Despite ecological, environmental and economic consequences, grassland conversion continues to occur across this region at a rapid rate (Wright and Wimberly 2013, Lark 2015). Doherty et al. (2013) report that current grassland loss rates far exceed habitat protection rates in the U.S. PPR and current conservation planning goals will not be met without significant increases in funding and public policy reforms. Other researchers suggest that a new era of U.S. agricultural policy may be characterized by rapid expansion of row crops on marginal lands, crop switching to more resource-intensive crops and landscapes increasingly dominated by monocultures with reduced biodiversity (Wright 2015).

Public policy plays an important role in PPR grassland conservation through various incentives and disincentives. For example, as part of the 2014 Farm Bill, Congress enacted a six-state (North Dakota, South Dakota, Montana, Minnesota, Iowa and Nebraska) "Sodsaver" provision that discourages conversion of native rangeland by reducing federal crop insurance subsidies on newly converted acreage, closes previous yield substitution loopholes and reduces taxpayer liabilities on disaster-prone lands.

Other federal programs like the North American Wetlands Conservation Act (NAWCA), Land and Water Conservation Fund and Federal Duck Stamp Act of 2014 (hereafter "duck stamp") provide significant federal funding for voluntary incentive-based grassland conservation programs. Throughout its 80-year history, the federal duck stamp program has generated nearly $900 million to protect more than 6.5 million acres of migratory bird habitat across the U.S.

Despite past and current political challenges, interest among private landowners for voluntary grassland conservation programs (both short- and long-term options) in the PPR remains high. Demand for these programs far exceeds current funding availability. In this presentation, I will highlight federal policy drivers, political challenges and urgent funding opportunities for increased grassland conservation efforts in the U.S. PPR.

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USING LANDSCAPE DESIGN PRINCIPLES TO CONSERVE GRASSLANDS UNDER NEAR-FUTURE FORECASTED AGRICULTURAL DEVELOPMENT

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The Southern Great Plains (SGP) contains ~585,000 km2 of North America's grasslands. The landscape of the SGP is a complex mosaic of short and mixed-grass communities interspersed with a number of

agricultural crops. U.S. Department of Agriculture and the World Bank commodity market forecasts suggest increases in aggregate demand for regional crops over the course of the 21st century due to forecasted global population and economic growth. It is unclear how increasing near-term agricultural demand will affect semi-natural grassland communities in the SGP and where conservation efforts could best promote grassland habitat for obligate species. We presented a landscape design for the SGP that demonstrates a systematic, model-based approach for: (1) ranking and identifying current grassland quality in the SGP based on habitat utilization by endemic species; (2) classifying and ranking the suitability of the region for dryland agricultural production on a 30 m2 scale; (3) forecasting potential changes in regional agricultural production using economic models for majority commodity crops; (4) simulating agricultural build-out and grassland conservation under future conditions using spatially-explicit models; and (5) demonstrating where conservation action could be taken on the landscape to benefit grassland obligate species. From 2015-2025, initial models predict a ~5% increase in the total area dedicated to agricultural production in the SGP and a transition from majority wheat production to cotton production for the region. Corn production is anticipated to increase due to continued technological advancement and favorable economic conditions, but is expected to remain a minority crop in the SGP as a whole. We demonstrated that core areas of semi-natural grasslands that are of high value for obligate species are isolated in areas currently unsuitable for dryland farming and are expected to remain so under future conditions. We identify target areas where conservation action can increase suitable habitat in the future.

MEASURING LAND-USE AND LAND-COVER CHANGE USING THE U.S. DEPARTMENT OF AGRICULTURE'S CROPLAND DATA LAYER: CAUTIONS AND RECOMMENDATIONS

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Monitoring agriculture and land use is critically important for understanding and managing food production, conservation, and climate change. The USDA's Cropland Data Layer (CDL), an annual satellite-derived land cover map, has been increasingly used for this application since complete coverage of the conterminous United States began in 2008. However, the CDL was designed and produced with the intent of monitoring annual land cover rather than changes over time. As a result, certain precautions are needed in multi-year analyses to reduce the probability of error and misapplication.

Here we highlight potential pitfalls ("cautions") and propose a set of recommended best practices and general guidelines to consider during use of the CDL. We also characterize a potentially problematic issue of missed cropland in earlier years of the CDL that should be corrected for when estimating changes to crops and cropland area. By explicitly discussing the methods and techniques for measuring land-cover and land-use change using the CDL, we aim to stimulate the discourse and development of methodology beyond what typically occurs during application of the product. Note that the recommendations suggested here are intended specifically for the CDL but are

Table 1: Limitations of the USDA Cropland Data Layer for monitoring Land Cover and Land Use Change (LULCC).

Task	Explanation	Example
Identifying land use	Like most satellite-derived remotely sensed data, the CDL can typically only identify land cover and does not natively provide information on land use.	Cannot distinguish forests used for timber production, livestock grazing, or unmanaged.
Distinguishing grassland vegetation	Due to their spectral similarity during remote sensing classification, it is difficult to accurately discern among various grassland vegetation types and uses.	Cannot identify native vs. non-native vegetation, difficulty discriminating pasture from hay.
Assessing area using direct pixel counting	Because fields often do not align with pixels, there can be sub-pixel area biases and adjustments required to measure acreage.	In NASS's use of the CDL for acreage estimations, a regression-based pixel-area adjustment factor is used.
Measuring incremental or pixel-level changes	Resolution limitations (30+ m) hamper capturing small changes in area, and annual edge effect can falsely suggest incremental changes along field boundaries.	Rural roads are typically <10m wide, leading to inconsistency in their mapping and that of the adjacent field edges over time.
Measuring changing field sizes or other landscape metrics	Improvements in the CDL classifications over time have reduced the occurrence of within-field speckle and apparent heterogeneity, influencing many landscape metrics.	Fields previously mapped as a checkerboard of 2 crops appear more continuous when correctly mapped as a single crop.
Directly comparing results across multiple U.S. states	Independent processing and classification of the CDL for each state often leads to inconsistencies across states, particularly noticeable along boundaries.	The 2008 Kansas CDL mapped almost all grassland as pasture/hay, generating higher estimates compared to its neighbors.
Measuring change between two isolated points in time	Assessing change using a bi-temporal "snapshot" methodology (i.e. using data only from the 2 years of interest without intermediate-year data) misses crop and cropland rotations and can multiply errors in the original data. Precludes temporal filtering.	CropScape online portal's web-enabled change analysis feature.

A list of common tasks performed during LULCC mapping with accompanying descriptions of the CDL's capabilities and constraints. An example of each situation is also included.

likely applicable to additional datasets including the National Land Cover Database (NLCD), Moderate Resolution Infrared Spectrometry (MODIS) land cover products, and other national and global land cover classification maps.

A number of initial precautions can be taken to help reduce the probability of error in measuring land use and land cover change (LULCC) using the CDL. A summary of common issues and tasks is presented in **Table 1.**

Table 2: Summary of recommended practices for measuring land cover change using the CDL

Recommendation	Details	Benefit	Example References Utilizing
Combine classes	Reclassify all grasslands, frequently rotated crops like corn/soy, or all crops into a single combined category where possible.	Reduces errors distinguishing among spectrally-similar land cover classes.	(Wright & Wimberly, 2013a) (Johnson, 2013) (Johnston, 2013) (Lark et al., 2015)
Utilize all temporal data	When measuring changes over time all available data should be used, including intermediate years.	Allows temporal classification and temporal filtering of likely misclassifications. Aids field boundary identification.	(Plourde et al., 2013) (Johnston, 2014) (Lark et al., 2015) (Sahajpal et al., 2014)
Integrate multiple data sources	Use additional remote sensing and/or ground-based data sources in combination with the CDL.	Improves confidence of findings, enables correction of individual product biases.	(Wright & Wimberly, 2013a) (Lark et al., 2015)
Establish minimum/ maximum Unit of Change (MUC)	Match change detection size to expected range of plausible changes.	Reduces mapping of spurious change. Improved signal to noise ratio.	(Cox & Rundquist, 2013)
Undertake post-classification Processing	Use field segmentation, a Minimum Mapping Unit (MMU), or spatial filtering to remove likely misclassifications.	Improves consistency between map representation and reality (fields, etc.). Reduces speckle. Better alignment with CDL capabilities (when use MMU).	(Sahajpal et al., 2014) (Wright & Wimberly, 2013a) (Lark et al., 2015)
Validate with independent data	Use published USDA statistics or other authoritative data to aid selection of processing and assessment methodology.	Improves selection of post-classification processing methods. Corroborates findings.	(Johnson, 2013) (Plourde et al., 2013) (Sahajpal et al., 2014) (Lark et al., 2015)
Adjust for areal bias	Use ancillary dataset or a regression estimator to correct for frequent crop underestimation bias.	Reduces false signals and exacerbated change areas due to CDL product improvement over time.	(Lark et al., 2015) (Johnson, 2013)

In addition to bearing in mind the above cautions, there are a number of additional recommendations to consider during application of the CDL for mapping LULCC (Table 2). Adhering to these broad guidelines while incorporating the previous cautions and cures will generally enhance the utility, accuracy, and consistency of analyses. Organized loosely by change detection processing steps, these guidelines are intended to provide starting advice on processing decisions that should ultimately be tailored for each specific analysis.

Lastly, we highlight a specific element warranting extra detail—correcting for crop underestimation bias and improvement. The accuracy of the CDL and its ability to fully capture major cultivated crops has improved over time. As a result, estimates of total cropland area based on the CDL alone suggest a substantial increase in total cropped area over time relative to other data sources. This trend can bias results when trying to quantify or detect specific land use or land cover trends, and is likely to manifest as an exaggerated signal of cropland expansion. The issue can be mitigated, however, by utilizing ancillary data from sources like the NASS Surveys or the NLCD.

When used appropriately, the CDL can be a valuable and effective tool for detecting diverse trends in agriculture. Adding knowledge of the common pitfalls and recommended practices presented here can help users create more reliable measures of post-classification LULCC using the CDL, thus further enabling critical analyses that improve our ability to understand agriculture and successfully navigate rising environmental challenges.

Note that the poster and extended abstract presented here describe preliminary results and conclusions. An expanded body of research and manuscript detailing the cautions, recommendations, and solutions is currently in progress and under peer review as "Recommended practices for post-classification land change analysis using the U.S. Department of Agriculture's Cropland Data Layer" by TJ Lark, RM Mueller, DM Johnson, and HK Gibbs. Contact lark@wisc.edu for more information or a draft of the full text and recommendations.

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2. SYMPOSIUM: MANAGING RANGELANDS AS SOCIAL-ECOLOGICAL SYSTEMS

Overview: The challenge of managing rangelands for multiple ecosystem services has prompted a growing interest in collaborative research and management approaches. This symposium brought together organizations, researchers and managers whose work recognizes that humans and rangeland ecosystems are inextricably linked. The objective of this symposium was to demonstrate and discuss how the conceptualization of rangelands as complex social-ecological systems can promote a two-way transfer of knowledge between rangeland stakeholders and researchers to enhance outcomes for society and nature. Specific cases from both sagebrush steppe and the central Great Plains illustrate how the social-ecological approach bridges disciplines and methodologies to enable collaborative research and promote adaptive management.

David Briske outlined the social-ecological approach. Briske discussed how application of collaborative adaptive management can address complex research questions and management issues. Retta Bruegger and colleagues from Colorado State University's (CSU) Learning from the Land Project discussed their use of participatory research to construct conceptual state-and-transition models of rangeland ecosystems, for understanding ecological change on rangelands in Northwestern Colorado and Wyoming. Trimmer et al. presented results from their study of Greater sage-grouse and sagebrush songbird habitat in Colorado, work that suggests greater sage-grouse may be an effective umbrella species for some sagebrush-obligate species. Monroe et al. spoke about their team's work to understand Greater sage-grouse population response to grazing management across 2442 BLM grazing allotments in Wyoming.

Speakers from Bird Conservancy of the Rockies highlighted the important role that non-governmental organizations play in building bridges across social groups for wildlife conservation in complex rangeland systems.

The symposium shifted from sagebrush ecosystems to work focused on the central Great Plains, where a collaborative team of researchers from USDA-Agriculture Research Service, Colorado State University, Texas A&M and UC-Davis are conducting an adaptive grazing management study. The first talk, co-presented by researchers and a Colorado rancher, provides insights into rancher mental models of complex ranching systems as part of a multiple case study of Colorado and Wyoming ranchers. The second talk, by David Augustine and colleagues, covered a 10-year adaptive management experiment wherein a group of rangeland stakeholders and researchers make data-driven management decisions for wildlife, rangeland and economic objectives on the short-grass steppe of Colorado.

The symposium concluded with a round-table Q&A discussion with the presenters and audience members facilitated by Maria E. Fernandez-Gimenez from CSU. The discussion provided the opportunity for clarifying and critical questions regarding the social-ecological approach. It also covered next steps for collaborative adaptive management and researcher/management partnerships.

MANAGING KNOWLEDGE, PEOPLE AND NATURAL RESOURCES TO PROVIDE ECOSYSTEM SERVICES

Presenter: David D. Briske, Texas A&M University

Human dependence on ecosystem services provides the foundation for social-ecological systems, and it also represents the source of the adage that 'natural resource problems are human problems'. Consequently, various social organizations and management strategies have been devised to maintain natural resources and supply ecosystem services. The imposition of regulations by federal organizations to limit harvest currently represents the most common management strategy. However, as the limitations of centralized management became apparent, it was recognized that some resource users were able to establish and enforce their own rules to maintain sustainable common use resources. This has contributed to development of a more localized and cooperative form of management among natural resource users described as collaborative adaptive management (CAM). However, this management strategy, although still in the early stages of development, has also encountered challenges that have limited success. Numerous reasons have been identified for the limited success of CAM, but human complexity - especially the limited ability to exchange and develop knowledge among stakeholders - has surfaced as a major challenge. This points toward development of greater awareness, skill and capacity to collaboratively exchange and develop knowledge that is relevant to critical natural resource decisions and tradeoffs as a fundamental challenge to natural resources management. This presentation will highlight recognized barriers to effective collaboration and knowledge exchange among stakeholders in grassland ecosystems. Confirmation bias, narrow framing of issues, insufficient trust, and varied mental models among stakeholders represent some of the barriers that contribute to the complexity of CAM. In addition, complexity associated with the exchange, blending and implementation of management, scientific and agency knowledge sources will also be addressed. Even though all knowledge sources are valuable, they are not equal in authority, purpose, or ease of understanding and exchange. Collectively, these emerging trends point toward development and implementation an alternative approach to natural resource management that engages diverse stakeholders, collaboratively develops knowledge, and promotes shared decision-making.

EXPLORING RANCHER MENTAL MODELS FOR ADAPTIVE MANAGEMENT: THE CASE OF LONESOME PINES LAND AND CATTLE

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Other Authors: Maria E. Fernandez-Gimenez, Colorado State University; Jim Sturrock, Lonesome Pines Land and Cattle Co.

Rangeland researchers have been studying grazing and rangeland management in southeastern Wyoming (Northern mixed prairie) and northeastern Colorado (short grass steppe) for over 75 years. Despite the wealth of knowledge developed through this work, a gap in understanding of adaptive decision-making processes exists between rangeland scientists and real-life managers who must make decisions under uncertain economic, socio-cultural and climatic conditions. The elicitation of rancher's mental models of ranching systems has the potential to reveal how managers perceive and adapt to system complexity. This presentation aims to explore rancher mental models for adaptive rangeland management through case studies of 16 Colorado and Wyoming ranchers. Through repeated interviews and ecological sampling, we are documenting rancher decision-making processes and their ecological outcomes, including rangeland species composition and habitat structure, over three years. One of the 16 case studies is the

Lonesome Pines Land and Cattle Company, presented here because it illustrates three common themes from the cases: 1) rancher concern for conservation; 2) ranchers' use of multiple ways of knowing, including experiential and scientific knowledge; 3) uncertainties around the future of the ranch. In this collaborative presentation between a rancher and researchers, Jim Sturrock, owner/manager of Lonesome Pines, presents his conceptual model of the ranching system, which includes a proactive, collaborative approach to management and a resistance to the status quo in ranching. In his decision-making Mr. Sturrock considers multiple levels of change in a globalizing cattle market and the long-term effects of his choices for grassland bird populations, rangeland plant species composition and the financial viability of his operation. He explains his use of climate, financial, rangeland monitoring and dendrochronology data to detect and adapt to change and manage for stochastic events. This study demonstrates the potential of collaborative, mixed methods research to build bridges between managers and researchers that support healthy rangeland social and ecological systems.

ADAPTIVE GRAZING MANAGEMENT FOR BEEF AND BIRDS IN THE WESTERN GREAT PLAINS

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Other Authors: Justin Derner and Lauren Porensk, USDA-Agricultural Research Service; Maria Fernandez-Gimenez, and Hailey Wilmer, Colorado State University

Sustainable grazing management strategies for forage and livestock production have been developed for the western Great Plains. However, managers have been challenged to consider broader management objectives due to ongoing declines and range contractions of many grassland birds and the desire to enhance perennial, cool-season grasses for increased productivity and vegetation structural heterogeneity. In 2012, we initiated an adaptive grazing management experiment in shortgrass steppe of Colorado where 10 stakeholders representing ranchers, government agencies, and conservation organizations were assembled to 1) choose and prioritize desired ecosystem services, 2) determine criteria and triggers for livestock movement among pastures in an adaptive manner to achieve desired services, and 3) select monitoring approaches to assess management success and inform adaptive strategies. Pastures managed by the stakeholder group are paired with pastures managed using traditional, season-long continuous grazing at the same stocking rate in a replicated experimental design. The first two years of stakeholder meetings demonstrated the importance of in-person meetings to discuss varying perspectives on the system's potential response to grazing management. Increasing the spatiotemporal variability in cattle grazing intensity emerged as a goal of the adaptive management treatment, with objectives for grassland bird recovery set at community/landscape scales, and for recovery of desired perennial cool-season grasses at ecological site/pasture scales. Technological needs identified include improved methods for rapidly summarizing and visualizing monitoring data at the landscape scale. Based on results from the first year of adaptive grazing implementation (2014; above-average precipitation), management for 2015 was adjusted to include (1) increase in stocking rate by 5%, (2) autumn patch burns in 25% of 2 pastures, to increase spring forage quality and generate mountain plover nesting habitat, (3) cattle movement among pastures based primarily on forage biomass thresholds. The effort has demonstrated the critical importance of control treatments and effective communication and follow up discussion of monitoring data for adaptive management.

Photo credit.

IDENTIFICATION OF WIN-WIN SOLUTIONS FOR LANDOWNERS AND WILDLIFE: THE KEY TO SUCCESSFUL CONSERVATION DELIVERY

Aaron Trujillo, Bird Conservancy of the Rockies

Other Authors: Gillian Bee and Tammy VerCauteren, Bird Conservancy of the Rockies

Within the contiguous United States ~ 70% of surface ownership is privately owned. Hence, the development of trust and partnerships between private landowners and conservation agencies and organizations is vital for the future of natural resources. Bird Conservancy of the Rockies recognizes private landowners and agricultural producers as playing a critical role in providing habitat for birds and other wildlife, as well as food and fiber for people.

Alongside partners, Bird Conservancy has dedicated significant efforts towards effectively identifying and implementing win-win solutions for landowners and wildlife. Bird Conservancy promotes a model of conservation based on a voluntary two-way transfer of knowledge between landowners and conservation professionals that starts through one-on-one visits, landowner workshops and being part of a rural community. These exchanges are the foundation for building trust and where the conversation on conservation begins and in time may turn into a significant contribution to natural resource conservation.

Bird Conservancy also has dedicated efforts to increase awareness of economic diversification opportunities available to private landowners and producers. Non-consumptive tourism opportunities such as the Colorado Birding Trail and Karvel Colorado's Mountain Plover Festival are opportunities for the general public to interact with the rural agriculture community, learn about its importance and voluntary efforts to natural resource conservation and at times provide income potential to these communities outside of ranching or farming.

The success of Bird Conservancy and partner efforts is due to the acknowledgment that the conservation of the rural American culture and conservation of wildlife go hand in hand. Multiple stakeholders' goals and objectives need to be considered, and one must adapt their method of conservation delivery to address this. Healthy wildlife habitat and healthy human communities can more than just co-exist; they can thrive with proper management and land stewardship.

WHAT DO WE LEARN FROM EACH OTHER? OPERATIONALIZING PARTICIPATORY RESEARCH IN NORTHWESTERN COLORADO RANGELANDS

Retta A. Bruegger, Colorado State University

Other Authors: Maria Fernandez-Gimenez, Cameron L. Aldridge, Jennifer Timmer, and Crystal Tipton, Colorado State University

Integrating local knowledge into research can provide key ecological insights. This talk will feature examples of observations and ideas from ranchers, and how these have influenced research questions and added to our interpretation of data over the past two years on Learning from the Land. Learning from the Land (LFTL) is an outreach and demonstration project that engages ranchers, agency staff from the BLM, NRCS and Forest Service, and professors, students and staff from Colorado State University. The main objective of LFTL is to use a collaborative process to build state-and-transition models (STMs), which are conceptual models for understanding ecological change on rangelands in Northwestern Colorado and Wyoming. LFTL integrates site-specific local and expert knowledge, and field data collection and analysis, to develop STMs. We use an iterative process where stakeholders and researchers meet regularly at formal STM modelling workshops and more informal field tours and discussions. Through these interactions, ranchers and other non-scientists contribute significantly to model creation and associated research. For example, one rancher in Moffat County inspired us to monitor insects, after he learned about the critical importance of insects to sage-grouse chicks. He also contributed other ideas based on his year-round observations of sage-grouse for the past 40+ years, and his own on-ranch experiments with alternative vegetation treatments to improve sage-grouse habitat. This is an example of how one rancher's observations and experimentation provoked us to look more broadly and deeply at ecosystem services and ecological relationships beyond our existing sampling plans. While research and model-creation processes that do not involve stakeholders on this level might be more straightforward from a logistical perspective, and not all ideas are "falsifiable" hypotheses, there can be specific benefits provided by meaningfully integrating ranchers' knowledge. Our approach provides one example of how integrating managers' knowledge and experience can add to overall understanding of ecosystem complexity.

INTEGRATING MONITORING DATA AND ECOLOGICAL SITE DESCRIPTIONS TO ACHIEVE MULTI-SPECIES BIRD CONSERVATION IN SAGEBRUSH RANGELANDS

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The apparent long-term population decline of sagebrush-dependent birds has elevated the recovery of the sagebrush avifauna to among the highest conservation priorities in North America. Because a large percentage of the sagebrush ecosystem occurs on private land, the successful recovery of the sagebrush avifauna may depend on partnerships between landowners and land managers. The failure to consider the interests of landowners and other stakeholders, and the lack of reliable knowledge about bird responses often conspire against conservation efforts in sagebrush rangelands. The objectives of the decision support system were to maximize 1) the suitability of Greater Sage-Grouse (Centrocercus urophasianus) nesting habitat, 2) the occupancy

rates of sagebrush-dependent songbirds and 3) the productivity of the grazing system. We considered four conservation practices that are typically used by land managers to improve nesting habitat for the Greater Sage-Grouse. We used Structured Decision Making to integrate the conservation problems, stakeholder objectives, management alternatives and biological outcomes within a Bayesian Belief Network that determined optimal conservation practices to achieve the objectives. We used data from the Integrated Monitoring in Bird Conservation Regions Program to model the songbird responses, and Ecological Site Descriptions and State and Transition Models to inform vegetation responses to grazing management. We discovered that conservation practices for improving Greater Sage-Grouse nesting habitat increased forage production for livestock and also increased the occupancy rates of the Brewer's Sparrow (Spizella breweri), Sagebrush Sparrow (Amphispiza belli) and Sage Thrasher (Oreoscoptes montanus). We suggest this approach is useful for answering the "what to do" and "where to do it" questions in conservation planning, as well as adaptive management and sustainable land use in working sagebrush rangelands.

MANAGING FOR MULTIPLE SPECIES IN NORTHWESTERN COLORADO: SAGE-GROUSE AND SONGBIRDS

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Reduction in sagebrush rangelands has resulted in sagebrush avifauna population declines across western North America, triggering a need to better understand relationships between environmental characteristics and avifauna occurrence. Sage-grouse may act as an umbrella species to manage for multiple species that rely entirely or partially on sagebrush rangelands, but the efficacy of such approaches is often assumed. Therefore, we surveyed greater sage-grouse [GRSG] and sagebrush songbird habitat use on private and public rangeland in Northwestern Colorado in order to create models of bird occurrence related to multi-scaled environmental features. We then determined the amount of habitat overlap between sage-grouse and three sagebrush-obligate songbirds (Brewer's sparrow [BRSP], sage thrasher [SATH], and sagebrush sparrow [SASP]). During May and June 2013-2014, we conducted standard point count breeding surveys for songbirds and GRSG pellet count surveys within a 10-m radius plot at each songbird point. We then modeled songbird or GRSG occurrence using remotely-sensed data, such as big sagebrush and herbaceous cover, to create generalized linear models and determine correlation in occurrence for GRSG and the three sagebrush-obligate species.

Occurrence for GRSG, BRSP, & SATH increased with an increase in big sagebrush cover, but each species responded to a different scale of sagebrush cover and different non-sagebrush predictors. There was a high, positive correlation between GRSG and BRSP and SATH occurrence ($r>0.75$). Occurrence for SASP increased with moderate amounts of big sagebrush cover, resulting in a negative correlation between predicted GRSG and SASP occurrence ($r < -0.25$).

In our study area, GRSG may be an effective umbrella species for some sagebrush-obligate species, but SASP appear to use areas with less shrub cover. Given the potential federal listing of GRSG, land managers and biologists should have an understanding of how managing for one species and its habitat could affect the provision of other ecosystem services (i.e., habitat for multiple sagebrush avifauna species).

GREATER SAGE-GROUSE (CENTROCERCUS UROPHASIANUS) POPULATION RESPONSE TO GRAZING MANAGEMENT AND PRECIPITATION ACROSS BROAD SCALES IN WYOMING

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Populations of Greater sage-grouse (Centrocercus urophasianus), an obligate sagebrush (Artemisia spp.) species in North America, have declined in recent decades, and they are being considered for listing under the U.S. Endangered Species Act. One land use type implicated in the decline of this species is grazing, as herbaceous cover may be important for sage-grouse nesting and brood rearing. However, population response to grazing management has yet to be evaluated across large spatial extents.

The Bureau of Land Management (BLM) currently oversees grazing on nearly 250,000 km2 of sagebrush land, and their records provide a unique opportunity to assess sage-grouse population response to rangeland management. We used grazing data collected by BLM from 2443 grazing allotments in the state of Wyoming to test population response of sage-grouse to the timing and intensity of grazing, and interactions with precipitation. We used annual counts of displaying males from 801 lek sites (2004-2014) and modeled population trends using state-space models in a Bayesian framework.

Preliminary results indicated a positive response to sagebrush cover, and a positive effect of grazing start date, particularly after drought years, suggesting that sage-grouse populations may benefit from delaying grazing until later in the growing season. While these trends remain to be tested at finer scales, our findings may guide future grazing management policies by BLM and other agencies, as well as on private lands.

Grazing in the Prairie Pothole. Photo credit: Aviva Glaser.

3. PARTNERSHIPS TO CONSERVE GRASSLANDS AND PROMOTE RANGELAND HEALTH

AN ADAPTIVE MANAGEMENT FRAMEWORK FOR MANAGING U.S. FISH AND WILDLIFE SERVICE PRAIRIES IN THE NORTHERN GREAT PLAINS

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The U.S. Fish and Wildlife Service (Service) Refuge System manages more than 222,000 acres of native mixed-grass and tallgrass prairie in the Northern Great Plains. Unfortunately, this important conservation reservoir of native prairie is extensively invaded by introduced cool-season grasses, principally smooth brome (Bromus inermis) and Kentucky bluegrass *(Poa pratensis).* This invasion was initially documented through limited inventories in North and South Dakota on Service prairies (Murphy and Grant 2005, Grant et al. 2009); however, recent results of a comprehensive inventory of Service prairies across North Dakota, South Dakota, and northeastern Montana have uncovered the full breadth of the invasion on refuge lands in the region. Native plant composition was, on average, less than 25%, while smooth brome and Kentucky bluegrass comprised 25-30% each. Given that prairies evolved with regular disturbances from fire and grazing, the common management history (circa 1935 – 1985) of long-term rest and little defoliation by natural processes on these Service lands has likely contributed to the loss of native plant composition. In addition, previous management efforts designed to suppress introduced grasses has had poor to inconsistent results, and even successful efforts have been short term and only involved a small number of units.

In order to restore these prairies, Service managers needed a decision support framework to guide habitat management and to systematically evaluate management effects on native prairies in the face of biological and environmental uncertainty. In 2008, the Service and U.S. Geological Survey (USGS) began a partnership to develop an adaptive management framework to assist managers in selecting best management actions and maximize learning from management outcomes. The Native Prairie Adaptive Management (NPAM) project currently includes 120 individual management units across 20 refuge stations. These stations span Minnesota, North Dakota, South Dakota and Montana and two administrative regions. The program spans the tallgrass and mixed-grass biomes, each of which is served by distinct models and management alternatives.

The underlying mechanisms of how native grasses and forbs respond to management are uncertain. Therefore, the NPAM framework utilizes expert-developed competing models that project a range of plausible prairie responses to specific management actions. The framework incorporates these models and accounts for the uncertain response of vegetation dynamics to management actions and uncontrolled effects (Gannon et al. 2013, Moore et al. 2013). Cooperators agreed on a limited set of management alternatives that, for mixed-grass units, include rest, graze, burn, and a combination burn/graze action. In the tallgrass units, the timing of management relative to plant phenology

is also considered as well as the option to use haying. Annually, the cooperators apply a management action and subsequently monitor the plant community composition using the belt transect method (Grant et al. 2004). The data are then uploaded to a centralized database for analysis (Hunt et al. 2015). Adaptive stochastic dynamic programming was used to identify the optimal management decision for the coming year in each management unit, given the present vegetative and defoliation states (i.e. frequency of defoliation through management). This recommendation is provided in time for managers to implement the action before the next growing season.

At the start of the NPAM initiative, there was complete uncertainty within the competing model sets for mixed-grass and tallgrass prairies, that is, all models in competition were equally credible. After six annual cycles, the relative weight or confidence in the models has begun to change. Currently, the simplest model, which hypothesizes that any defoliation is better than rest, has incrementally gained the most weight for both mixed and tallgrass biomes. All of the models were initially parameterized with expert opinion. In general, experts predicted small, incremental changes in vegetation annually but the data are showing much larger changes. It could be that the simplest model does describe the system best, or it may be that it is better equipped to handle that kind of variability. This may be resolved in the future when there are enough data to define the parameters empirically and replace the expert opinion.

In addition to reducing uncertainty through the modeling framework, adequate data on the response to treatment have accumulated in the mixed-grass prairie biome to preliminarily evaluate the overall trend. The unit-level annual percent of native grasses and forbs was modeled as a function of prior-year annual precipitation, invasion vulnerability (based on Natural Resource Conservation Service's Ecological Site Descriptions), and the management treatment, as well as the two-way interactions between precipitation and treatment, and between vulnerability score and treatment. Additional factors were included to account for recognized sources of variability not of central interest, including the site's climatic position (long-term averages of annual precipitation and maximum temperature of the warmest month), the prior-year amount of native prairie, a year random effect, and transect-level random noise to account for overdispersion. When all predictor variables are held to their mean values, the overall trend in native plant response since the initiation of NPAM is positive. Although a definitive answer to whether NPAM is achieving its intended conservation purpose is not yet possible, these results are the first indication that the program is working, at least in the mixed-grass portion of the range.

For the Service, NPAM is a new way of doing business and implementing science-based management in a structured way. Through this project, refuge staff are using the same protocols and making management decisions that are transparent, linked to an objective, based on the current state of each unit and the current understanding of system response to management, while explicitly taking into account the uncertainty in this understanding. By working together in this way as a coordinated effort toward a common objective, the Service hopes to accelerate the restoration of native prairies under refuge management.

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NEW WAYS OF WORKING TO CATALYZE THE FUTURE OF FARMING

Allison Van, Winrock International

The Pasture Project is a multi-facetted partnership that conserves and expands acreage in well-managed pasture, benefiting water quality, wildlife habitat, carbon sequestration, and small farm profitability. The Wallace Center at Winrock International, with support from the Walton Family Foundation, initiated the project in 2011 to work with farmers and farmer supporters in the Upper Mississippi River Basin. Last year, Pasture Project and partners helped farmers and landowners improve conservation practices on more than 10,000 acres vulnerable to runoff by implementing approaches ranging from increasing grazing intensiveness to grazing cover crops on row crop fields and converting row crop fields to pasture.

The Pasture Project operates with a basic premise: we do not know how to motivate farmers and landowners to improve conservation practices on millions of acres within current policy and financial contexts. Although there is significant experience informing best practices, there is no single, straightforward answer and adoption of conservation practices remains low compared to need. So the Pasture Project has stepped away from more traditional models and embraced experimentation and design thinking.

In practice, the project is developing, testing, evaluating or scaling more than a dozen approaches at the same time. Approaches are targeted at different audiences and geographies with unique theories of change. Each viable idea goes through several rounds of initial review (developing) and is then piloted (testing). During testing, regular data reviews support adjusting the approach. At the end of a pre-determined testing phase (generally six months to three years) a determination is made whether the approach should be expanded, contracted or ended. This process is informed by rigorous quantitative and qualitative evaluation. Project staff examine the return on investment of each approach in terms of improved management of acreage in the short-term and the increased capacity by place based organizations/individuals to help farmers better manage over the long-term.

The Pasture Project. Photo credit: Allison Van.

Examples of approaches, target audiences, locations, and stages of development:

Approach	Type of Work	Audience	Location(s)	Stage of development
Whole Farm Planning Partnering with other organizations to meet all conservation-focused technical assistance (TA) needs; relationship managers direct TA according to farmer/ landowner wishes	Direct Technical Assistance	Farmers/landowners with over 100 acres	Pilot in Kickapoo Watershed, Wisconsin	**Developing**
Grazing Cover Crops Planting multi-species cover crops in row crop fields and grazing with cattle in fall or spring	Demonstration sites	Row Crop farmers, grazers, conservation community, farmer supporters	6 farms in Minnesota and 2 in Iowa	**Testing**
Adaptive High Stock Density Grazing A grazing methodology that focuses on flexibility to suit the land, livestock and farmer's lifestyle	Demonstration sites	Conventional cow-calf producers or backgrounders (beef and dairy)	5 farms throughout Illinois	**Testing**
Grazing Champions Current grazers with 2-10 years of experience are trained in media and presentation and given opportunities to become spokespeople for grazing	Outreach	All farmers and landowners	Throughout Upper Mississippi River Basin	**Testing**
Land Trust partnership Partnering with a land trust to combine easements and long term management plans as well as finding viable tenants	Land Access	Conservation-minded landowners	Pilot in Kickapoo Watershed, Wisconsin	**Evaluating**
USDA-AMS Grassfed Beef Report An official federal pricing report to bring transparency to the market	Policy	All considering or engaged in grassfed beef production	National	**Complete**

The Pasture Project's structure poses many challenges to and unique opportunities for effecting change. Researching and piloting such a variety of approaches demands project staff and partners think critically about and remain engaged with many highly distinct pieces of work. The project must simultaneously forge new directions and respond to changed circumstances, partner needs, and the feedback from farmers and landowners about existing approaches. Project staff must decide regularly how to balance time between multiple needs. Although there is widespread acknowledgment that complex problems require adaptive solutions, implementing a truly flexible and adaptive approach has been challenging and requires a level of discipline in objectively evaluating progress that, as staff grow attached to different approaches, can be difficult to muster.

Two particularly interesting trends have developed as the project has grown. First, staff and partners are combining approaches in key watersheds where there is potential to improve management on at least 10% of the acreage within five to ten years. Wisconsin's Kickapoo River Watershed is the first site where as many as eight approaches are coming together. The area has a long history of sustainable agriculture but suffered a major setback when several years of high corn prices led to thousands of acres of grassland and pasture being converted into corn production. Together with a dozen cross-sector partners—including Trout Unlimited, The Mississippi Valley Conservancy, USDA-NRCS, Wisconsin Department of Natural Resources (DNR) and Wisconsin Grassfed Beef Cooperative – The Pasture Project is working to convert tens of thousands of acres back to grass through a diverse array of interventions.

The partnerships directly engage with non-operating landowners around leasing decisions, work with Wisconsin DNR to open select public land to conservation graziers, create grazing plans and help producers access EQIP funds, combine easements, grazing plans and lease brokering, continuously feed compelling stories to local media, host field days, train new technical assistance providers, and will soon launch Whole Farm Planning assistance. At the same time, Pasture Project staff are working with partners to identify 1-2 other watersheds to focus long-term efforts. This on-the-ground work is expected to complement region-wide initiatives and national level policy and messaging work.

Second, The Pasture Project emphasizes joint financing as a means of forging partnerships and strengthening buy in. As the project's funding has grown, the percentage of funding dedicated to a specific approach in a particular stage of development is declining, largely because participant farmers and partners are taking on some of the financial responsibility. An excellent example of this is the Grazing Cover Crops demonstrations in Minnesota and Iowa. To match funds received from USDA-NRCS through their Conservation Innovation Grant program, two new funding partners began supporting the Pasture Project. Three implementing partner organizations more than matched the funds provided to cover their implementation responsibilities. Participant farmers picked up half the costs of equipment and seed, and local seed companies notably discounted mixed species covers. Sharing both costs and credit widely has deepened the partnerships both among the organizations and with the individual farmers. What started as a Pasture Project approach has become so collaboratively owned that the nature of our strategy has naturally evolved and decentralized. This level of collaboration among farmers, organizations, and sectors is what the Pasture Project strives for across approaches.

Developing and maintaining substantive relationships allows each organization, landowner, and farmer to hone individual strengths and maximize impact. As a project that encourages staff and partner farmers and organizations to imagine and propose new innovations, then test and accept results, there is a dynamic energy to the work and significant progress in shifting acreage to better management. Although working with many partners to implement so many approaches is a challenge, the Pasture Project team believes dynamic and creative partnerships are essential for landscape-level change.

SUSTAINING BIRD POPULATIONS WITH A CONSERVATION ATLAS AND CHANGE STRATEGY FOR MIDWESTERN GRASSLANDS

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Despite decades of conservation attention, grassland bird populations are declining faster than any other group of breeding birds in North America, with especially pronounced decreases occurring in the Midwest. Agricultural intensification and land-use change have contributed to the declines via widespread habitat loss and degradation. In response, conservation agencies and organizations have identified large remaining grasslands and grassland complexes as priorities for protection and restoration. Recently, these groups have partnered to create a network of grassland landscapes in order to support implementation of local, state and regional conservation plans. Coordinated by the US Fish and Wildlife Service, the Midwest Grassland Network has begun to consolidate spatial information and strategic guidance to uphold the ecological and societal values of native, restored, and surrogate grasslands.

The Conservation Atlas for Midwest Grassland Birds will be an online mapping tool and information clearinghouse serving the eastern Prairie Potholes, Upper Mississippi River - Great Lakes, and Central Hardwoods ecoregions. It will combine existing information with new data to support decisions at multiple scales. Atlas users will view priority grasslands in relation to current conservation boundaries, bird locations, and areas targeted for water-quality and pollinator protection. A complementary ranking tool will allow users to build their own spatial models from a selection of ecological and economic data in order to identify stewardship opportunities. Specific applications include: conservation design and gap analysis; project ranking for grants, easements, purchases, and incentive programs; coordination of research and monitoring; land-use education; and partnership building.

Recognizing the limits of current methods, the Midwest Grassland Network has also convened an interdisciplinary graduate seminar to develop a change strategy that addresses key drivers. The seminar engages biological scientists, social scientists, decision-makers, and graduate students in weekly dialogue at the University of Minnesota. Participants in this conservation deliberation are charged with synthesizing policy, economic, and social approaches into a few alternative pathways for sustaining grasslands in the Midwest. The seminar report will present context-specific recommendations linked to representative landscapes highlighted by the atlas. Upon completion in 2016, the change strategy and atlas will guide efforts to achieve lasting benefits in areas of greatest opportunity.

HABITAT EXCHANGE

Ted Toombs, Environmental Defense Fund

Habitat Exchange is a new conservation program being developed by EDF and its partners in several states across the US. The purpose of the Habitat Exchange is to protect, restore, and conserve habitat value for a variety of species and ecosystems. Its goal is to provide financial and regulatory incentives and stimulate greater involvement of the private landowner community in this conservation. In many cases, Habitat Exchanges are being used as an innovative way to expand on the conservation banking model for mitigation. They also serve as a means to more accurately quantify the outcomes of conservation practices.

For each Habitat Exchange, EDF and its partners have developed three basic documents to guide the operations and functioning of the program including: 1) An operations Manual, 2) A legal Agreement, and 3) A Habitat Quantification Tool. These are the tools of the Exchange.

This presentation focused mostly on the Habitat Quantification Tools (HQT) being developed for the Greater Sage Grouse in Colorado. The purpose of the HQT is to serve as a currency enabling apples to apples comparisons of impacts and offsets in mitigation and quantify outcomes of conservation practices. The Greater Sage Grouse HQT is habitat function based and includes the following components: 1) A methods document describing the science and metrics used, 2) A User's Guide outlining the Geographic Information Systems steps, 3) A calculator used to calculate an impact or offset using measures of habitat function, and 4) A Field Guide describing data collection and sampling methods. The presentation focused on describing the components and metrics used in the HQT and how those components are combined to derive an impact or offset evaluation.

LEOPOLDIAN LAND STEWARDS – FOSTERING A LAND ETHIC

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Other authors: Rob Thompson, Elster Ranch,Wendell Gilgert and Geoff Geupel, and Kelly Weintraub Point Blue Conservation Science

The Rangeland Watershed Initiative team at Point Blue Conservation Science is partnering with Leopoldian Land Stewards (ranchers that display a land ethic, among other characteristics) to build upon their inherent desire to steward their land for the benefit of livestock, wildlife, their families, and future generations. Above all, the Leopoldian Land Steward is a leader in their community, organization, and/or industry, engaging with and encouraging others to adopt a land ethic. Through a partnership with the Natural Resources Conservation Service and others, Point Blue partner biologists are facilitating the implementation of rangeland conservation practices with the objective

Partnering with producers: science and ranching find common ground on a northern California ranch. Photo credit: Kelly Weintraub.

of re-watering California's rangelands. Using the above profile, the partner biologists identify ranchers who are leaders in their community who can inspire a land ethic in others to ensure long-term stewardship of ecological and ranch production benefits of California rangelands. The Partner Biologists assist the Leopoldian Land Stewards to 1) accomplish their conservation goals on their ranches, 2) involve them in ongoing training and networking with other Leopoldian Land Stewards, and 3) provide mentoring and ranch tours to other ranchers in their community.

POINT BLUE CONSERVATION SCIENCE'S RANGELAND WATERSHED INITIATIVE: REWATERING CALIFORNIA, ONE RANCH AT A TIME

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Other Authors: Geoff Geupel, Breanna Owens, Elizabeth Porzig, Point Blue Conservation Science; John Baker, WildAid

Modeled after Northern California's Upper Stony Creek Watershed Project (Wondolleck and Jaffee 2000), Point Blue's Rangeland Watershed Initiative Partner Biologists work closely with the NRCS, and conservation partners to assist ranchers with adjusting grazing management of domestic livestock in order to shift rangeland vegetation from the current naturalized annual plant dominated communities to plant communities that include more perennial plant functional groups (Henneman 2014) in order to:

- More effectively capture, hold and slowly release water from rain, snow, fog, and dew
- Reduce incidence of bare soil
- Increase soil organic matter (SOM) (A 1% increase in SOM holds an additional 16,500 gallons of water per acre)
- Encourage vigorous plant photosynthesis
- Increase livestock forage
- Increase and improve fish and wildlife habitat
- Protect Open Space and
- Keep Ranchers ranching

The changes in grazing management engage a spectrum of rancher management actions that can range from relatively simple shifts to very complex manipulations of management systems. An example of a comparatively simple shift would be a ranch that subdivides one large pasture into three to five smaller pastures. The smaller pasture subdivisions allow plants a rest from herbivory during the growing season. More intensive prescriptions, occur where domestic grazing mimics herbivory of native ungulates that were influenced by large predators (Edwards, S. W. 1992) as well as Native American and natural fire regimes and seasonal rest. Planned grazing systems are designed to manage livestock in order to control the **time** (season(s)) of use, **intensity** (number of livestock), duration (hours, days, weeks) that the livestock have access to individual plants and the **disturbance** (hoof action, incorporation of dung/urine) applied to plants and soil in individual pastures.

Point Blue Partner Biologists collaborate with NRCS Field conservationists, RCD's and an array of conservation partners, to provide "value-added" fish and wildlife discipline technical recommendations for ranchers to plan, design, implement, and monitor prescribed rangeland grazing and conservation management practices. NRCS conservation practices that facilitate grazing and natural resource management, are enhanced by associated facilitating and accelerating conservation practices. NRCS assessment tools like Wildlife Habitat Evaluation Guide's (WHEG's) and Stream Visual Assessment Protocol2 (SVAP2) are utilized to provide producers with resource inventories and conditions for both pre (benchmark) and post land treatment. Another element of the "value added" characteristics of Point Blue Partner Biologists is that they are trained and mentored to be what Aldo Leopold described as "Land Doctors" (Leopold, R.A. 1949) where they are able to "read landscapes" in order to ascertain the health of the land as it is manifest in the functionality of ecological (water and mineral cycles, energy flow, biotic integrity, pollination, etc.) processes.

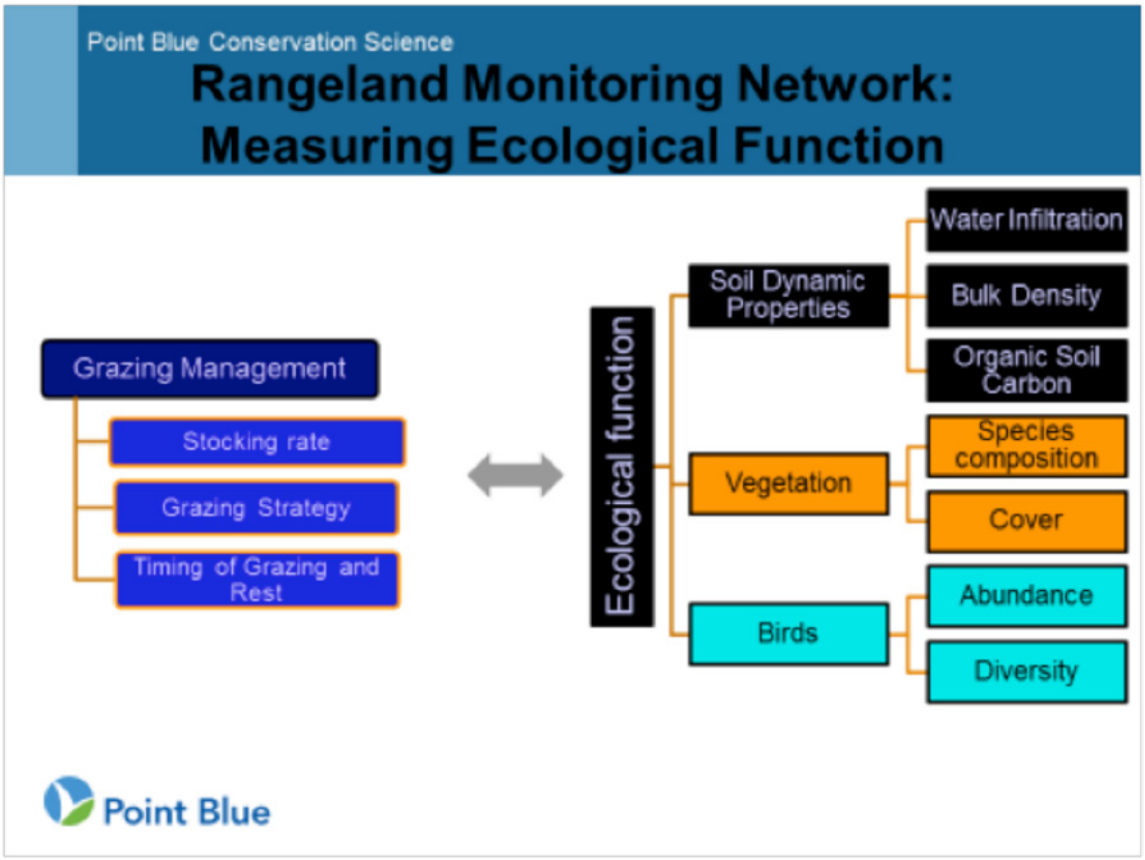
With financial support through NRCS Farm Bill programs, cooperating ranchers utilize climate smart technical assistance from Point Blue Partner Biologists, NRCS conservationists, and other conservation partners and are increasing soil water retention in foothill watersheds, improving water supply reliability downstream, increasing soil organic matter, enhancing ranching productivity, and expanding riparian corridors and wetland habitat for migratory birds and other wildlife.

A major component of RWI is that Point Blue is developing a model where Partner Biologists are embedded in the community in which they work, by living in the local community, by being involved with local producer (Farm Bureau, RCD's, Cattlemen's and Woolgrowers Associations, Etc.) and Community (county fairs, local symphony's, Audubon Chapters, etc.) groups, thereby building and gaining trust that allows for the Partner Biologists to be respected, sought after, and valued members of their local community.

In addition, we are partnering with, cultivating, encouraging, and mentoring ranchers as Leopoldian Land Stewards as a way to help ensure long-term stewardship of ecological and production benefits on their land. Ranchers are well known for their animal husbandry. Our goal is for rancher land stewardship to be equally known and recognized. With assistance from the Aldo Leopold Land Ethic Leader (LEL) Program, we have developed nearly three dozen techniques that engage, enhance, encourage and help cultivate Leopoldian Land Stewards.

Rangeland Monitoring Network

Point Blue's RWI companion effort, the Rangeland Monitoring Network (RMN) is measuring hydrological function restoration and soil carbon, changes in vegetative trends, and the wildlife habitat benefits of the prescriptive grazing and associated rangeland management practices. The multi-year study will provide empirical evidence on the efficacy of prescribed



Keeping Grasslands Healthy

Using birds to measure the health of your California grasslands

Why should you care about grassland health? Healthy grasslands are important habitats for birds and other wildlife, and also places where we farm and ranch. They provide food, cover, space and safe access to water for both wildlife and livestock. Since not all grassland birds use the same type of grassland, you may not find all of the birds listed below in one place. Take note which birds are associated with which type of grassland, as indicated at the top of the table. **How do you know if your grassland is healthy?** Look for these grassland bird species — together they feed and nest in different areas of healthy grassland habitats throughout most of California, including rangelands in and around the Central Valley. **If the birds are there, your grassland is healthy!**

	Open, tall grasslands				Savannah grassland		
	Grasshopper Sparrow	**Savannah Sparrow**	**Golden Eagle**	**Northern Harrier**	**Lark Sparrow**	**American Kestrel**	**White-tailed Kite**
							
Tips for a Healthy Habitat	Promote native bunch grasses through restoration and prescribed grazing.	Maintain open grassland areas and promote native bunch grasses.	Maintain open foraging habitat, especially areas with abundant rodent prey such as ground squirrels.	Maintain fields with tall, permanent vegetation and hedgerows.	Maintain and restore native bunch grasses and oak woodlands around grasslands.	Maintain standing dead trees for perches and nest cavities. Consider installing nest boxes.	Maintain fields with tall vegetation in grasslands and oak savannahs.
How to Identify	A small, mostly brownish sparrow with an unmarked buffy breast, and a dark crown with pale middle stripe. Song is an insect-like buzz.	Brown above and white below with streaks throughout, often with a small yellow patch in front of the eye. Pink legs.	One of the largest birds in North America; adults dark brown with golden sheen on back of head and neck; immatures with white patches in wings and tail.	Medium-sized raptor with distinctive white patch on the rump; males are gray and whitish; females brown with black bands on tail.	A large sparrow with a striking face pattern, whitish underparts with a dark spot on breast, and a long, rounded tail with white corners.	A small falcon with black vertical "sideburns" on the sides of their faces. Males have slate-blue wings; females wings are reddish brown.	Medium-sized slender hawk with long, narrow, pointed wings. Gray back and wings with black shoulders, white face and underside. Hovers to hunt.
Nest Site	Nests of grass built on ground in dense vegetation, often at base of a large tuft of grass.	On ground in tall grasses.	Usually nests on cliff ledges, though sometimes in large trees.	On the ground in wetland or other dense, tall vegetation.	In vegetation on the ground, though sometimes low in a shrub or tree.	In tree cavities (usually old woodpecker holes), but will readily use artificial nest boxes.	In trees, usually along the edge of open habitat.
Diet	Mostly insects (especially grasshoppers).	Insects and seeds.	Small mammals, especially ground squirrels.	Mostly small to medium sized rodents.	Seeds and insects.	Large insects, rodents, birds, and reptiles.	Mostly rodents.
Time of Year	Spring—Summer.	Mostly winter in the Central Valley.	Year-round.	Year-round (more common in winter).	Year-round.	Year-round (more common in winter).	Year-round.

Grassland Bird Focal Species Landowner handout (CPIF 2000)

grazing and rangeland management practices in providing more effective water cycling, improved soil quality, sequestered soil carbon, increased vegetation functional group diversity, reduced invasive weeds, and improved wetland, riparian, and upland fish and wildlife habitats.

Schematic of relationship of RWI grazing management to RMN monitoring RMN data collection includes the use of bird point counts that utilize *Bird Focal Species,* which are common bird species, to apprise the health of broad target habitats (grasslands, Oak Woodlands, Riparian, and Mountain Meadows). Bird focal species, by their presence or absence in a particular habitat type, tell us volumes about the health of those habitat types. We use *vegetation monitoring* to measure soil cover, apprise of vegetational shifts in the number of functional groups as well as serve as measures of increases or decreases in invasive or noxious plant species.

Finally, we measure the *soil dynamic properties* of bulk density (a measure of soil compaction), soil carbon, and water infiltration. Dynamic properties can and do change with land management. Taken together, we term our measurements "performance monitoring" because once the data is taken, we analyze it and within a short interval (less than a year), the information is made available to the rancher. The analyzed data is discussed with the rancher who then decides if adjustments are needed with their grazing or conservation plans.

We are beginning our fourth year of Point Blue's Rangeland Watershed Initiative. We understand that returning and moving land to healthier function is a

long term process, but are seeing numerous positive indicators of progress. We believe that we have developed some unique RWI attributes that can and will be adapted more broadly. Those attributes are:

- Use of Bird Focal Species to guide management
- Embedded Partner Biologists trained as "Land Doctors"
- Encouragement and Cultivation of Leopoldian Land Stewards
- "Performance Monitoring" to support planning, implementation and assessment (monitoring) of conservation actions of the land

Taken together, with Rancher and Conservation Partners' collaboration, we will collectively and successfully Rewater California, One Ranch at a Time!

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USING AVIAN FOCAL SPECIES TO INFORM RANGELAND MANAGEMENT IN CALIFORNIA GRASSLAND AND OAK SAVANNAH

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Other Authors: Bonnie E. Eyestone, Point Blue Conservation Science, Billy S. Freeman, Sierra Foothill Conservancy

Conservation of private working rangeland is a growing priority for many and is important for protecting biodiversity (Maestas et al. 2003). California rangeland that are protected from development and intensive agricultural uses provide many important ecosystem services, including sequestering carbon, capture of rain water, and enhancing biodiversity (Alvarez 2011, Byrd et al. 2015) . Birds have great indicator power (Bock 1997) and are excellent indicators of grassland conditions (Browder et al. 2002). Moreover, managing habitat for a suite of focal species can prevent the loss of species from landscapes used for productive enterprises such as grazing (Lamback 1997).

Historically many land trusts and conservation organizations have focused on land acquisition and private landowners on production. Now many of these entities recognize the need for better rangeland stewardship to maintain and perhaps increase biodiversity and livestock production (Alvarez 2011.) Thus a more holistic approach to ranch planning is required to engage landowners in effective stewardship that protects ecosystem services in a rapidly changing climatic environment.

Point Blue Conservation Science (Point Blue) over the last 3 years has directly engaged over 395 ranchers and 9 different land trusts and helped carry out conservation measures on over 300,000 acres of

rangeland, including over 150,000 acres in prescribed grazing management (Gilgert and Owens 2015). This conservation work has involved prescribing 43 different conservation practices, from fencing for prescribed grazing systems to riparian plantings for improved wildlife habitat.

Effective, successful management planning has to include the needs of the landowner and the grazing lessee or private rancher who manages the land. Most importantly, planning must identify those beneficial practices that meet the objectives of all interested parties. After implementation, these practices should be evaluated and modified as needed—an approach often called adaptive management, which is the foundation of good land stewardship.

Point Blue recently started a major new program that is hiring "partner biologists" to assist private landowners in carrying out climate-smart conservation practices. Through an ongoing partnership with the Natural Resources Conservation Service (NRCS), Point Blue has placed 14 partner biologists in California NRCS Field offices to work with ranchers, land trusts, and the local

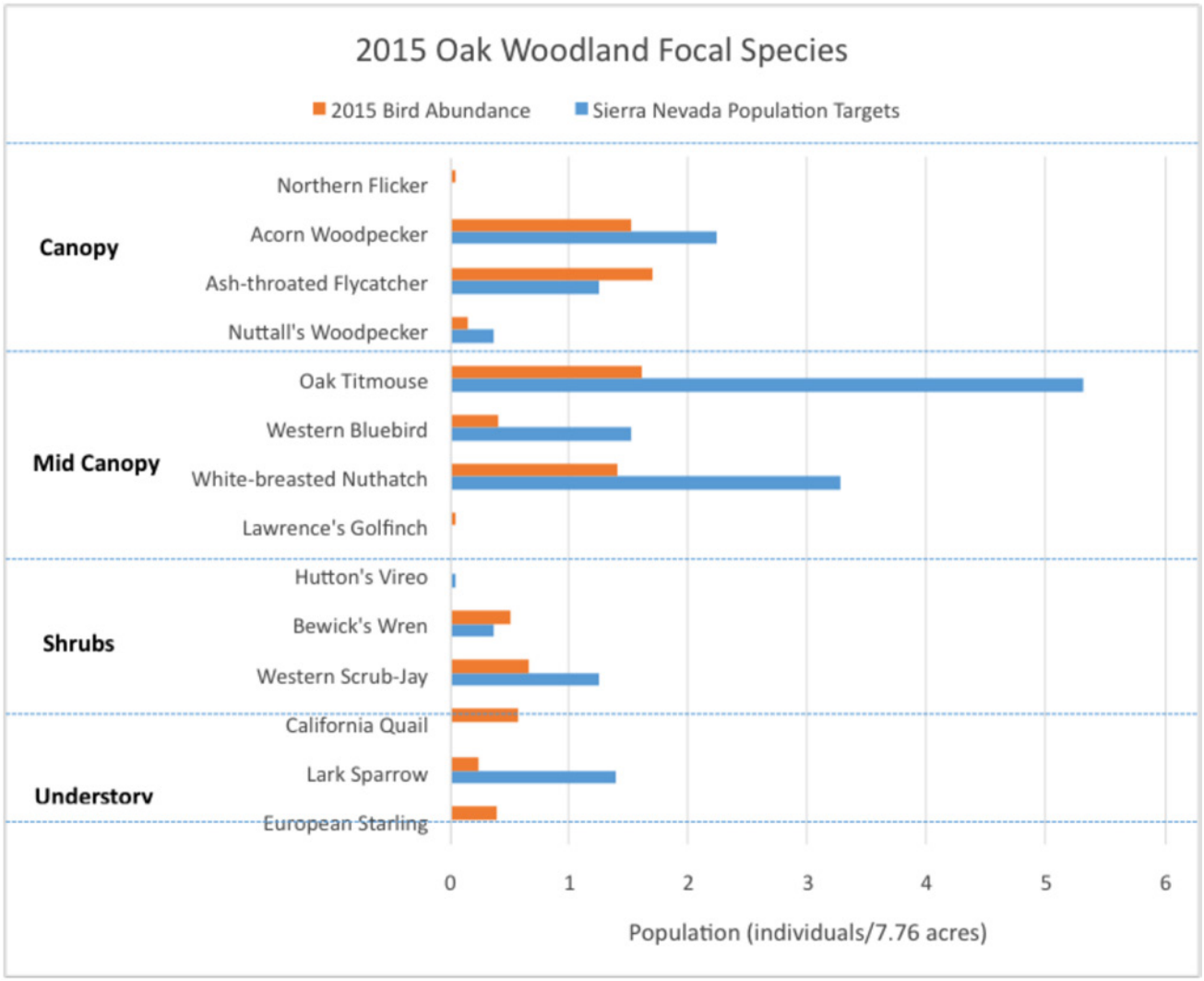


Figure 1. Sierra Nevada Population Targets taken from Zack et. al 2005, Ch.5 pg 50-53.

community (Gilgert and Owens 2015). A unique aspect of the program is that partner biologists are required to monitor the effectiveness of the practices prescribed. Monitoring bird focal species – species that are indicators or umbrellas for other species or represent important habitat features or processes (see **http://www.pointblue.org/our-science-and-services/conservation-tools/resources-by-audience/planning-tools/** for complete list of focal species by habitat) - before and after project implementation has been extremely effective in guiding conservation for private landowners and land trusts. The monitoring uses standardized surveys of bird focal species that are representative or indicators of important ecosystem processes and/or habitat elements or umbrellas (Chase and Geupel 2005, Zack et al 2005) to evaluate existing conditions and effectiveness of practices prescribed (Young et al. 2015). Additional monitoring both pre and post implementation focus on metrics such as water infiltration, soil bulk density carbon content , and vegetation to assess ecological function (Porzig et al. 2015).

An example of using focal species for planning and evaluation is provided by the Sierra Foothill Conservancy (SFC) working in collaboration with a Point Blue partner biologist (B. Eyestone). SFC owns a 2960-acre preserve in Fresno County with a goal of conserving oak savannah and grasslands that includes using grazing to enhance biodiversity and ecosystem health. In 2013, SFC chose to exclude grazing on the majority of the McKenzie Preserve for a period of 18 months to allow recovery from previous over-grazing effects. Low residual dry matter (RDM) levels observed during the fall of 2013 required the removal of livestock by the preserve management plan for protection of soil resources. SFC also prioritized conservation objectives that included a shift from Filaree (Erodium spp.) dominance in many areas to a more healthy and diverse understory. Figure 1 shows the results of efforts to monitor birds and associated vegetation of this habitat after a year's resting period from livestock grazing.

The number of oak woodland focal species detected in the 2015 breeding season is compared to regional population targets that have been established for the Sierra Nevada Foothills. The population targets are based on what we would expect to see in healthy, diverse oak woodland.

Results suggest that important primary cavity nesters (i.e., birds that excavate their own holes) such as Acorn Woodpecker and Nuttall's Woodpecker, which live in the canopy, are present but are falling short of population targets. This indicates that mature oaks, which provide cavity sites, and Foothill Pines and older oaks, which are acorn granary or storage trees, are available; however, bird numbers may be down because of a poor acorn crop during the current multi-year drought. Secondary cavity-nesting species (i.e., those that use holes excavated by other species) such as Oak Titmouse and Western Bluebird populations may be facing nest predation and competition with European Starling.

In general, 12 of the 14 oak woodland focal species are distributed across McKenzie Ranch but mostly use areas with the most canopy cover as well as the riparian area. The east side of the property is west facing and has greater canopy cover and thus greater focal species richness. Using ArcGIS, Point Blue mapped focal species abundance and distribution to identify areas that would benefit from specific habitat improvements and those where the current management practice is providing high quality wildlife habitat. Overall, focal species richness improved from 2014 to 2015 (Eyestone 2014).

These results led to the following management recommendations, which were incorporated into a grazing management plan for the Sierra Foothill Conservancy's McKenzie Ranch:

- Use rotational grazing annually based on plants' phenology in order to promote desirable vegetation for a diverse and healthy understory.

- In areas where oak woodland species are at low density, improve the understory and shrub layers by allowing for ample rest periods in grazing rotation; continue protection of blue oak seedlings; create brush piles to provide immediate understory cover; maintain shrubs in high densities.

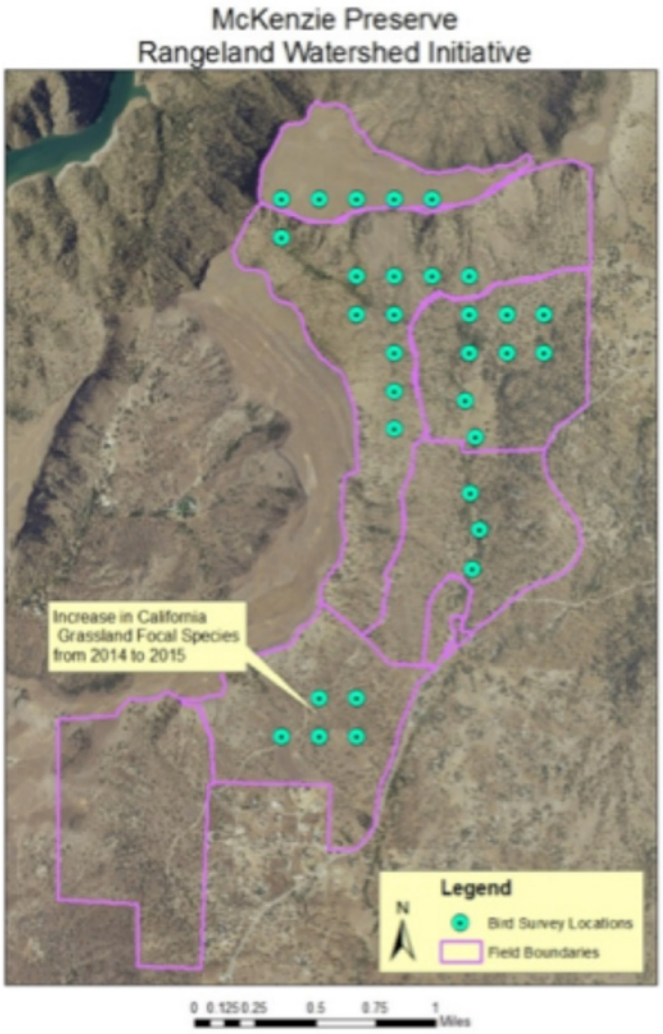
• Manage for a mosaic of tree canopy covers; retain large, mature and acorn producing oaks and those trees that are actively being used as granary trees or cavity trees, including snags and downed wood.

• Create a separate riparian pasture for flash grazing to promote growth of riparian vegetation to increase riparian bird focal species richness. Flash grazing can also reduce noxious weed pressure in the riparian area.

• Continue monitoring and adapt management to achieve goals and objectives.

These management recommendations also formed the foundation of a conservation grazing plan that was funded by the Environmental Quality Incentives Program (EQIP) in the 2014 Farm Bill. The EQIP is a voluntary program that provides financial and technical assistance to agricultural producers for up to ten years. Monitoring will continue to determine the effectiveness of these practices for the focal bird species. Results from this year have already shown an increase in Lark Sparrows and Loggerhead Shrikes, both Grassland Focal Species.

By encouraging land trusts and other private landowners to carry out these habitat management practices, California's rangelands are becoming better able to retain water, produce forage for livestock, sequester carbon, and conserve biodiversity—to keep the land healthy and productive for wildlife and people.



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USING RANGE WIDE COLLABORATIONS TO CONSERVE PACIFIC NORTHWEST PRAIRIES

Elspeth Kim, Center for Natural Lands Management

Prairie-oak habitats of the Willamette Valley – Puget Trough – Georgia Basin (WPG) ecoregion in the Pacific Northwest are one of the most imperiled habitats in the United States. Washington State's Puget Trough has seen a >90% loss of native prairie with only 3% of the remainder dominated by native vegetation. Similar rates of habitat degradation and loss have occurred in Oregon's Willamette Valley (>99% loss) and British Columbia's Georgia Basin (95% loss). This corridor of grasslands tucked amongst the coniferous forests of the Pacific Northwest supports a suite of unique flora and fauna. The loss of this important habitat has led to decline of many associated species and the federal protection of 11 species including the streaked horned lark, Taylor's checkerspot, and golden paintbrush.

Protecting and recovering these vulnerable species is not straight forward. Many of the species of focus occur on both sides of an international border within three different jurisdictions – the Canadian province of British Columbia and United States' Washington and Oregon, each containing a large urban area – Portland (OR), Seattle (WA) and Vancouver (BC). The result of urbanization, fire suppression policies, and land conversion has led to a decline in both absolute and high quality prairie and oak habitat within the historic range. To address the complex and urgent need for conservation, the Center for Natural Lands Management (CNLM) has helped create a network of partnerships and a collaborative environment in western Washington and beyond.

CNLM's South Sound Prairies Program began addressing the need for the conservation of prairie habitats and species in Washington over 20 years ago. The South Sound Prairies Program formed an early partnership with nearby Joint Base Lewis-McChord (JBLM), which hosts the largest expanse and highest quality prairie in the region and is occupied by many key species. This partnership, originally focused on controlling invasive scotch broom on the military installation, has since expanded to include a suite of restoration actions including tree and shrub removal, prescribed fire, invasive species control, and seeding of native plants. Restoration and recovery of off-base lands and species expanded in 2006 through the Department of Defense's Army Compatible Use Buffer (ACUB) Program, which aims to reduce Endangered

Species Act associated limitations to training by supporting the conservation of listed species on lands outside the base. Participating in the ACUB Program has allowed CNLM and other South Sound partners to protect key lands, increase habitat quality, recover rare species, and build the conservation infrastructure necessary to effectively restore lands and increase the numbers and sizes of target species populations. One such example is the South Sound conservation nursery that has grown with the support of ACUB to meet the growing needs for native seed. This cooperative plant propagation program provides seed to multiple partners in the region and by doing so achieves economy of scale in the production of prairie and oak species. The partnerships and programs that were expanded with ACUB funding support built the foundation for South Sound Prairies to become the nation's first Sentinel Landscape in 2013, a new partnership between three federal agencies: Defense, Interior, and Agriculture. This designation provides increased support to advance the shared goals of all three agencies: military readiness, endangered species, and private working lands. Each department uses their existing programs to provide regulatory certainty, funding, and technical support.

CNLM implements a comprehensive conservation program built on strong partnerships, which are key to on-the-ground success. Built on a partner-focused foundation, programs such as ACUB, recovery grants from the US Fish and Wildlife Service, funding from state programs and myriad other sources have combined to support on the ground restoration across partner sites utilizing shared resources such as prescribed fire, native seed production, and expertise. In addition to partnerships within the South Sound region, species-focused efforts such as working groups and special initiatives have expanded the network of partners to cover the historic range of prairie and oak habitats in the Pacific Northwest. These collaborations have resulted in new populations of our rarest species, thousands of acres of additional protected lands, and dramatically increased habitat quality.

Building off of this strong foundation of collaboration, the formal partnerships between South Sound entities, and informal partnerships with entities and individuals throughout the WPG, the Cascadia Prairie-Oak Partnership (CPOP) was formed. This partnership brings together members of the prairie oak conservation community from throughout the entire WPG ecoregion to provide range-wide, landscape-scale coordination on prairie conservation. Through a website, listserv, and technical library, information is better exchanged. Through special workshops, initiatives, and shared grants, the CPOP community is able to conduct more effective work on the ground that is part of a bigger effort, resulting in improved outcomes. One of our key tools for sharing information, linking entities, and generating incentives is our range wide species-specific working groups. Since 2010, CNLM has coordinated working groups for the Streaked Horned Lark, Taylor's Checkerspot Butterfly, and Mazama Pocket Gopher, all species that were listed in 2013/2014 and that co-occur on JBLM and throughout the WPG. CPOP creates formal and informal opportunities for the conservation community to better identify landscape scale needs, seize opportunities, and improve on the ground outcomes.

Local and range wide collaborations among conservation partners is key to maximizing on the ground outcomes. Cooperative conservation eliminates silos, maximizes resources, and shares expertise to allow the best ideas to be implemented in the most efficient and effective way. The Center for Natural Lands Management and the entities and individuals participating in the Cascadia Prairie-Oak Partnership use these strategies to protect and enhance remaining prairie and oak habitat and species.

UTILIZING STAKEHOLDER DEVELOPED GRASSLAND CORRIDORS TO GUIDE COLLABORATIVE HABITAT RESTORATION IN NORTHERN ARIZONA

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Other Authors: Steve Rosenstock, Steve Cassady, and Hannah Griscom, Arizona Game & Fish Department

As part of a larger vision of connected and functional grassland habitats across Arizona, the Arizona Game & Fish Department (AGFD) develops strategic, spatially explicit, and collaborative habitat planning tools with our diverse partners. The following is an overview of recent planning efforts in Northern Arizona that have successfully incorporated these tools.

In 2004, the Department and the Arizona Linkages Working Group initiated an effort to map wildlife movement corridors throughout the state. Subsequently, AGFD partnered with Coconino County, and several other counties, to develop more detailed corridor maps that inform land use decisions. These corridors serve to connect important habitats for a variety of wildlife, including wide-ranging and specialist species. Corridors were mapped during a series of collaborative workshops; stakeholders were asked to draw important movement areas and habitat connections, and to provide detailed information on the wildlife species served, the nature of the data justifying each corridor, and threats and opportunities for corridor conservation. Corridors have been incorporated into numerous planning efforts in the region, including the Flagstaff Regional Land Use Plan, Coconino County Comprehensive Plan, and the Four Forests Restoration Initiative Final Environmental Impact Statement (published April 2015).

The Department has led several telemetry studies to better understand wildlife movements in relation to highways and other development, habitat treatments, wildfires, and other features. Currently, AGFD Wildlife Contracts Branch is tracking dozens of pronghorn in and around the Flagstaff area, providing valuable information about travel corridors and barriers. With these data, we are able to identify critical migratory routes and target our habitat improvement projects to these areas. As we implement strategic mechanical treatments, fence modifications, and prescribed fires, we will be able to track behavioral responses from the movement data.

The Coconino County stakeholder-developed corridors formed the basis for strategic layout of grassland and montane meadow forest treatments within the first analysis area of the Four Forests Restoration Initiative (4FRI), a 2.4 million acre Collaborative Forest Landscape Restoration project in Northern Arizona. Within open grassland and meadow wildlife corridors, treatments were designed to be generally more open, taking into account soils, topography, and existing conditions. As we receive more telemetry location data, we are further refining these treatment recommendations. 4FRI highlights opportunities and lessons learned from our work on federal lands.

The 4FRI Collaborative is a diverse group of Stakeholders with long-held individual concerns about forest management. In order to maintain our recommended open corridor treatments, amid concerns over retaining large trees and canopy cover on the landscape, several factors were critical. We generated white papers supported by our stakeholder corridors and most recent movement data to identify the most critical areas for open treatments. The combination of an inclusive workshop process and scientific data created a credible recommendation that proved compelling to the 4FRI Stakeholder Group. The Department maintained constant engagement with the US Forest Service Interdisciplinary Team, serving as a cooperating agency and providing EIS support.

Building upon the successes of the Central Arizona Grasslands Conservation Strategy **(http://www.azgfd.gov/w_c/grasslandsConserv.shtml)**, Department staff in the Flagstaff area are mapping existing and potential grasslands to guide large-scale habitat improvement projects. We have several critical partnerships in place, including cost-share positions with the Natural Resources Conservation Service. With strategic, data-driven spatial planning, it is our hope to integrate work on private, state, federal, and other lands to provide functional connectivity for our grassland-dependent species while promoting resilient systems in Northern Arizona.

Arizona Game and Fish Department. 2011. The Coconino County Wildlife Connectivity Assessment: Report on Stakeholder Input. Arizona Game & Fish Department, Region II, Flagstaff, AZ.

MULTI-INSTITUTIONAL COLLABORATIONS TO MANAGE FEDERALLY PROTECTED AREAS

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Other Authors: Brian Miller and Shantini Ramakrishnan; Denver Zoological Foundation; Richard Reading, Independent Conservation Biologist

Rio Mora National Wildlife Refuge and Conservation Area became the nation's 560th Wildlife Refuge in September 2012 and represents a unique and unprecedented collaborative partnership. The 4,224-acre refuge in Mora County in New Mexico is owned by the United States Fish & Wildlife Service (USFWS) and since December 2012 managed, thought a memorandum of understanding, by The Denver Zoo. Of the 560+ wildlife refuges across the country, Rio Mora is the only one where USFWS has stablished a partnership with a non-governmental organization to manage 100% of its conservation, education, outreach and research efforts, all refuge staff are Denver Zoo employees. Additionally, New Mexico Highlands University supports a half-time position at the refuge to facilitate numerous graduate research, and provide GIS expertise. Rio Mora is also home to a tribal herd of bison owned by the Pueblo of Pojoaque. This herd fulfill conservation, cultural, educational and research objectives. Every winter, following grassland surveys, stocking rates are set by Denver Zoo biologists to maintain ecological function and processes, and excess bison is harvested using traditional practices, and used by the Pojoaque for cultural purposes and food programs.

Rio Mora NWR also carries the designation of conservation area. This status allow this partnership to actively engage with landowners in the 1 million acres Rio Mora watershed, and the future acquisition of conservation easements and fee titles. Some of the conservation actions undertaken by this partnership in the last 2.5 years include: Landowner workshops on erosion control, grassland management, and river restoration; place-based conservation education programs for 4-12 grade students; research on plague ecology, restoration ecology, amphibians and reptiles, and bison effect on grassland ecosystems. Currently the refuge is in the process to obtain NEPA clearance in order to initiate other conservation and research initiatives as prescribed burning as ecological driver, river restoration, reintroduction of native species, expansion of our bison conservation and management, and engagement on landscape conservation. The memorandum of understanding supporting this partnership is due to be renewed in 2015, and given the success during this initial period, 15+ years of commitment have been considered by all partners.

Luis Ramirez/Rock Dam at Rio Mora Conservation Area

RESULTS OF GRASSLAND STAKEHOLDER SURVEY OF COLLABORATIVE GRASSLAND MANAGEMENT APPROACHES

Mollie Walton, Quivira Coalition

Other Author: Bob Rogers, The Nature Conservancy

The purpose of the The Nature Conservancy (TNC) survey conducted by the Quivira Coalition was to ask grassland stakeholders for their assessment of the current threats to native grassland habitats and their assessment of the most useful progressive management techniques for maintaining or improving the remaining grassland habitats in Arizona and the boot heel of New Mexico. Quivira and TNC identified grassland stakeholder groups to query for information on practices, policies, and partnerships that both negatively and positively affect grassland health. Results of this survey indicate that supporting the social aspects of land management partnerships may be just as important as promoting and implementing best management practices on the ground.

For the purposes of this study, stakeholders were grouped into categories: ranchers, grassland experts, federal, state and county agency personnel, Tribal natural resource specialists, conservation groups and sportsmen who fall within the geographic scope of grassland habitats in Arizona and the southwestern New Mexico boot heel. Individuals within each stakeholder group (category) received a survey with questions that were tailored to their experience and area of expertise in addition to a core set of questions that remained the same across all groups.

Groups and individuals were selected for this survey based on their geographic location within grasslands in Arizona and southwestern New Mexico and/or based on a deep knowledge of, or interest in, these ecosystems. All of these stakeholders were chosen because of their reputation for belonging to a successful collaborative management group or belonging to a multigenerational ranching family in the region. The sample of individuals is not random, but purposive. This snowball method of sampling has yielded a larger list of people with whom we interacted to complete the surveys. Results are summarized and presented as averages or percentages where questions required a quantitative response.

Table 1. Highest rated threats to grassland health.

	1	2	3
Rancher/Land Manager	Prolonged drought	Altered fire regime	Bureaucratic obstacles to progressive grassland management
Grassland Expert	Prolonged drought	Poor grazing management	Conversion to shrubland
Conservation Group	Prolonged drought	Altered fire regime	Conversion to shrubland
Agency Personnel	Altered fire regime	Conversion to shrubland	Poor grazing management Bureaucratic obstacles to progressive grassland management

Sixty-nine grassland stakeholders completed the survey of 258 people who received the survey request. This is a 27% response rate to the survey requests. Stakeholders were asked to rank 15 known threats to grassland health from most to least important. They were then asked to choose only the three greatest threats, and the results from the refined question are presented in Table1 (with 1 being the highest rank, and 3 being the lowest). There was a tie between poor grazing management and bureaucratic obstacles to progressive grassland management for agency stakeholder responses to the question. Most of the top threats were ecological in nature, except for the ranking of bureaucratic obstacles.

All grassland stakeholders surveyed were members of many organizations outside of their primary affiliation. Ninety percent of the ranchers/land managers were also part of at least one conservation organization. Of the rancher/land manager stakeholder group, 64% percent were members of other organizations unrelated to land management such as church groups and other community groups. We asked stakeholders in the rancher/land manager category, *What/if any benefits did you experience from being part of a collaborative group?* Most reported benefiting from their interaction with a collaborative group. Figure 1 shows the reported benefits.

All stakeholders were asked to rank the importance of 28 different social, economic, and ecological methods for maintaining and restoring healthy grasslands. The highest ranking items in order of importance were drought management planning, improved monitoring, erosion control, brush control, prescribed fire, and mentoring for the next generation of grassland managers.

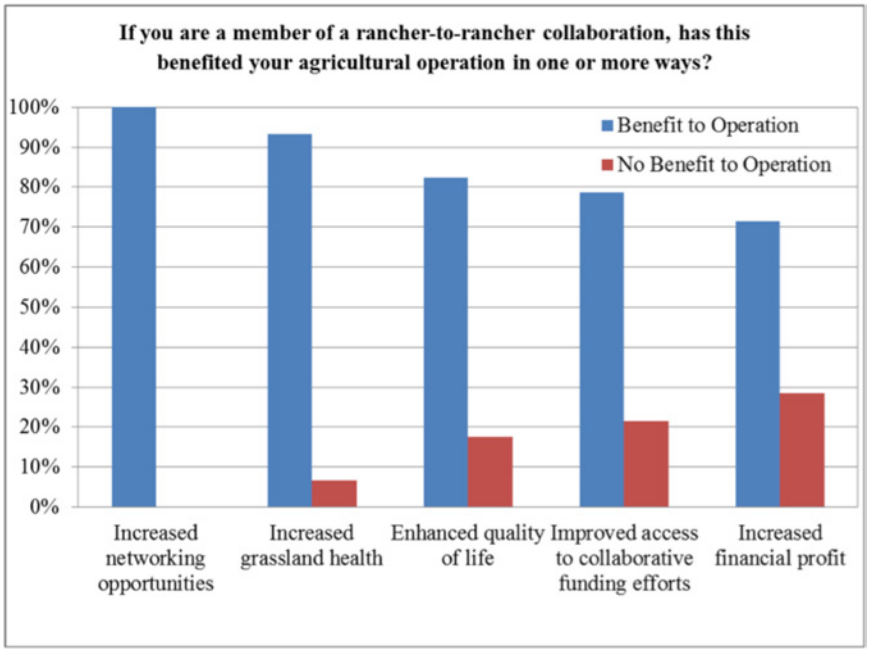


Figure 1. Benefits of belonging to a collaborative group.

Another question asked what sources ranchers/land managers turn to for information needed to make grassland management decisions. The majority of ranchers/land managers cite the sources that they go to the most for information as the United States Department of Agriculture, National Resource Conservation Service (USDA-NRCS) and other land managers. The next most common sources of information were internet research and neighbors, followed by farmer/stockman journals. All stakeholders surveyed would attend a workshop on ecological or economic practices if it were offered in their region and many would travel as far as 100 miles to attend a workshop.

We asked stakeholders, *What would be the best collaborative model to sustain grasslands?* The greatest number of ranchers/land managers chose watershed groups as the best collaborate model rather than rancher-to-rancher collaboratives as the best working model. Agency personel were equally divided between collaborative models.

Finally, in our follow-up interviews with grassland stakeholders, we ask a subset of questions that allow people to expand on the issues surrounding grassland health and ranch sustainability in their own landscape and then for the larger Southwestern landscape. One of the most important questions asked people to expand on parternships that work and hypothesize about why there are not more partnerships such as the Malpai Borderlands Group and the Altar Valley Conservation Alliance.

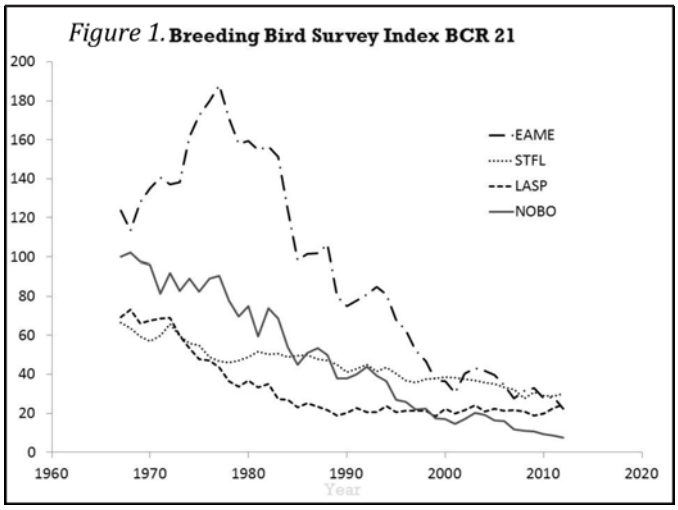
The consensus to this question was that a "champion" needs to lead the group and people must be willing to follow that leadership. Stakeholders suggested that one of the biggest policy changes that could be made to improve grassland health would be to allow funding for programs that will allow support for the leadership of collaborative groups. Without salary or support for their efforts to sustain the collaborative groups, often these leaders choose to place their substantial efforts elsewhere. Healthy grassland systems are an essential ecosystem, and supporting the resiliency of the rural people and businesses managing grasslands is perhaps the very best management practice for maintaining and restoring these landscapes.

EMPOWERING LANDOWNERS TO ACHIEVE CONSERVATION GOALS, THE OAKS AND PRAIRIES JOINT VENTURE

Jon Hayes, Oaks and Prairies Joint Venture

Other Author: Jim Giocomo, Oaks and Prairies Joint Venture

The Oaks and Prairies Joint Venture (OPJV) is a regional, self-directed partnership of government and non-governmental organizations and individuals working across administrative boundaries to deliver landscape-level planning and science-based conservation, linking on-the-ground management with national bird



population goals. In Bird Conservation Regions 20 and 21, where the OPJV efforts are focused, addressing grassland bird population declines *(Figure 1)* is a major priority for the OPJV partner organizations.

Through the Grassland Restoration Incentive Program and other related efforts, this partnership has made a significant investment in delivering grassland habitat improvements at the landscape scale. To that end the OPJV staff and management board members are constantly exploring new and innovative means of working with private landowners to deliver conservation gains. One area that shows significant potential in this regard is what is often referred to as "new conservation" in which grassroots, stakeholder-driven, collaborative conservation efforts are increasingly supplanting the more top-down government led programs of the past and in doing so showing tremendous ability to achieving conservation success.

In western states collaborative stakeholder groups and landowner cooperatives have become an increasingly effective way to promote ecosystem integrity and services that provide the clean water, clean air, and healthy wildlife populations that growing populations enjoy and depend on. There are a number of examples nationwide of successful stakeholder groups that achieve real conservation results. The Blackfoot Challenge in Montana, and the Malpai Borderlands

Group in the southwest being two of the more successful examples of landowner-centric groups that engage industries, governments, and various Non-governmental Organizations (NGOs) in meaningful ways.

Formation of landowner cooperatives need to be supported by agencies and NGOs concerned with delivering conservation gains on private lands, however the challenge to governments/large organizations is finding an appropriate way to provide support, when, in many cases, their involvement is either not desired, or can decrease the sense of ownership and empowerment that members feel as a result of their local origins. One potential strategy is to provide support in the development and capacity building, or "growth stage", of these organizations rather than in the formation. In effect, we may not be able to provide the "why", but possibly can assist with the "how", of building an effective organization.

Private industry has long recognized the value of supporting entrepreneurs with promising ideas through the fragile early stages of starting a new business. In the past decade this idea has taken the shape of incubators or accelerators which provide not only capital, but mentors and networks of similarly positioned individuals that provide an environment conducive to successful development of new ventures. We propose to borrow from the technology startup world's playbook and develop a *Conservation Cooperative Leadership Incubator* (CCLI) modeled after the successful approach increasingly employed by venture capitalists in places like Silicon Valley, Boulder, London, and throughout the world's various other tech centers. Our proposal is to use such 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.

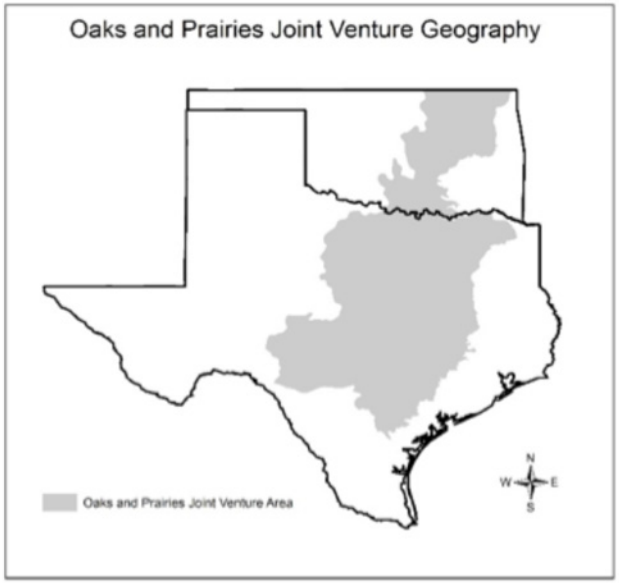
The OPJV staff is currently seeking funding to support the development of the CCLI through hiring of a coordinator and development of curriculum and resources. Interested partners are encouraged to contact Jim Giocomo or Jon Hayes to learn more about how their organizations can get involved and support this new and innovative approach to empowering private landowners to achieve conservation goals.

OAKS AND PRAIRIES JOINT VENTURE: STRATEGIC HABITAT CONSERVATION FOR GRASSLAND BIRDS ON WORKING LANDS IN OKLAHOMA AND TEXAS

Jim Giocomo, Oaks and Prairies Joint Venture

Other author: Jon Hayes, Oaks and Prairies Joint Venture

In an effort to address the decline of bird populations in the grasslands of Oklahoma and Texas, a number of state and federal governmental agencies as well as various non-governmental conservation organizations have partnered to form the Oaks and Prairies Joint Venture (OPJV) to more strategically and collaboratively deliver conservation gains in this region. OPJV has worked to implement a fully integrated Strategic Habitat Conservation framework that works at multiple



scales to conduct biological planning, landscape conservation design, habitat tracking and bird monitoring in support of a robust conservation delivery portfolio.

Over the past 8 years, OPJV partners have worked together to identify priority grassland birds conservation needs, and devise cooperative strategies to meet those needs. This planning resulted in the recent publication of Oaks and Prairies Grassland Conservation Business Plan consisting of four main strategies, and a diversified portfolio of activities under those strategies to balance potential risk and reward (figure 1).

The first strategy is (#1)to provide financial incentives through our signature conservation delivery program, the Grassland Restoration Incentive Program (GRIP), which since it was created in 2013 has improved habitat for grassland birds on over 38,000 acres of working lands in focus areas throughout the OPJV geography. Other strategies include (#2) supporting local land owner cooperative conservation efforts, (#3) developing market-based conservation delivery strategies, and (#4) implementing a strategic communications strategy.

The OPJV partnership and staff are intimately involved with many of these efforts and continue to provide support in the form of biological planning, conservation design, and monitoring of bird populations. The great work that staff from OPJV partner organizations conducts every day across this region must serve as the foundation for any effort to deliver restored populations of grassland bird species (see figure). The OPJV Grassland Bird Conservation Business plan outlines strategies that will serve as needed supplements to existing efforts work. The strategies outlined will complement the work already being done and fill in gaps in areas that may have been overlooked up to this point.

The partners of the Oaks and Prairies Joint Venture worked together to establish shared bird population goals and grassland habitat objectives for the Oaks and Prairies Bird Conservation Region (BCR) and the Edwards Plateau BCR. To address our need to track progress toward these shared goals and objectives, OPJV partners established several programs to measure our progress. To track the progress of partner conservation activities, the OPJV partners worked with Gulf Coast Prairie Landscape Conservation Cooperative

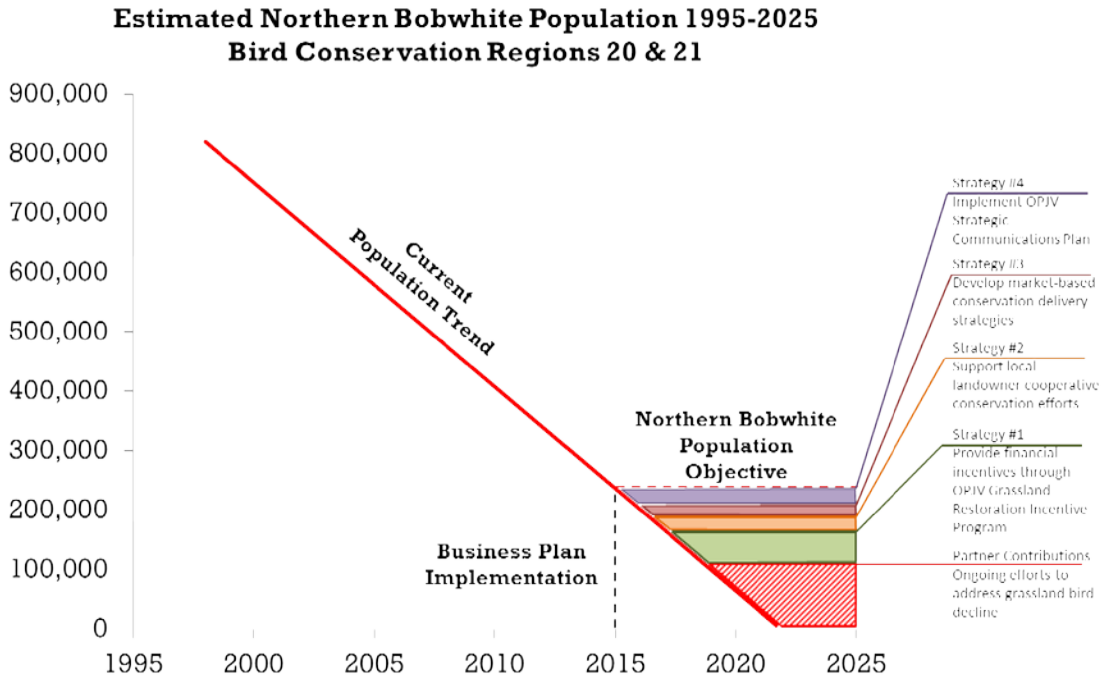


Figure 1.

biologists and the Advanced Applications Lab of the US Geological Survey to build an online land management tracking platform that can be used across organizations. Our Grassland Management Inventory Tool (G-MIT) allows individual users to login under their respective organization to enter spatially-explicit, standardized grassland management information while maintaining privacy of landowner information.

To measure the impact of habitat management efforts on priority bird populations, OPJV staff members are working closely with Texas Parks and Wildlife Department and Oklahoma Department of Wildlife Conservation staff to conduct county level coordinated bird population monitoring protocols based upon a ten-year time scale. Several universities are helping these state agencies to collect the data and conduct analysis. We are collecting bird population data at the county scale to enable analysis with USDA county level Agricultural Statistics, and other partner grassland conservation efforts tracked by the G-MIT. Finally, the OPJV Grassland Technical Team is working with local agency biologists and local universities to use information collected in the population monitoring and the G-MIT to address assumptions and refine models used to establish the original population objectives.

We are working under an adaptive management framework, Strategic Habitat Conservation. Our landowner incentive program, GRIP, is accompanied by a full complement of conservation delivery programs that support landowner cooperatives, utilize market-based conservation delivery strategies, and implement strategic outreach and communications, all of which are described in the OPJV Grassland Bird Conservation Business Plan. Future efforts will include incorporating grassland habitat needs of declining insect pollinators and Monarch Butterfly populations that overlap with habitat needs for our priority grassland birds.

NORTHERN PLAINS CONSERVATION NETWORK - CONNECTING CONSERVATION

Northern Plains Conservation Network participants

The Northern Plains Conservation Network (NPCN) is a collaboration of more than 25 non-profit and tribal organizations working together for over fifteen years to conserve and restore the wildlife, habitats, and ecological processes of the Northern Great Plains. Participation is open to all who support our vision and mission. Our vision is a sea of grass supporting healthy wildlife populations and human communities. We seek to enable, energize, and inspire participating organizations by linking our efforts in support of this vision. The mission of the NPCN is to restore and maintain the native species, habitats and natural processes of the Northern Great Plains. Our strategy is to work in partnership with those who live, work and recreate in this region to identify and maintain the areas that best contribute to this mission.

To succeed, we must identify and link much larger areas than are designated for wildlife and habitat today. We must begin to think and to act on a different scale – the scale of natural processes (e.g. wildlife migrations, fire, hydrology) that transcend municipal and political boundaries. We employ science, public education, private sector initiatives, and advocacy to promote our vision of a sea of grass supporting healthy wildlife populations and human communities.

The NPCN:

- **Informs** people locally, regionally, nationally and internationally about the vision, and about the ecological values and characteristics of the Northern Plains;

- **Develops opportunities** for greater participation in key NPCN issues;

- **Accesses and analyzes data** needed for furthering the NPCN vision;
- **Shares approaches and information** about common issues of concern to NPCN participants; and
- **Identifies initiatives** needed to implement the NPCN vision.

Our two current initiatives focus on bison and grassland birds, including Greater Sage-grouse.

NPCN has a focus on grassland birds as they are one of the most imperiled habitat-based group of birds in North America. Trends of populations decline is largely consistent across types of grassland birds: migrants and residents, gamebirds, shorebirds, songbirds, hawks, and owls. This is alarming as birds are indicators of ecosystem health. Grassland birds are also important for economic, esthetic and cultural reasons. Many changes in land development, land use policies, and grazing can occur that would benefit grassland habitats and birds, with minimal financial costs to ranchers and other landowners, and perhaps even benefits. Examples of simple changes include consideration for: the timing of disturbances relative to bird breeding activities, the area requirements of birds beyond pasture fences to achieve habitats more appropriate in size; and the rotation of grazing among pastures to increase habitat heterogeneity with no change in animal production.

NPCN is working to share best management practices and other information on methods for land managers and others to support healthy bird populations for priority species. NPCN has produced information sheets for Greater Sage-grouse, Burrowing Owl, Mountain Plover and Long-billed Curlew. These are all available to the public on the NPCN website (www.npcn.net).

Bison is the second area of focus for NPCN. For 10,000 years, bison were the dominant herbivore in North America, and their grazing patterns influenced the structure of grass species, mosaics of vegetation, and fire dynamics, which in turn influenced habitat for grassland insects, birds, and small mammals. The decimation, gradual domestication and increased husbandry of bison in enclosed spaces has begun the steady process of rendering the bison "ecologically extinct." The majority of land in the region is privately owned and grazing for cattle production is the dominant use. However, based on prior historical situations and current models we believe bison and cattle can be compatible.

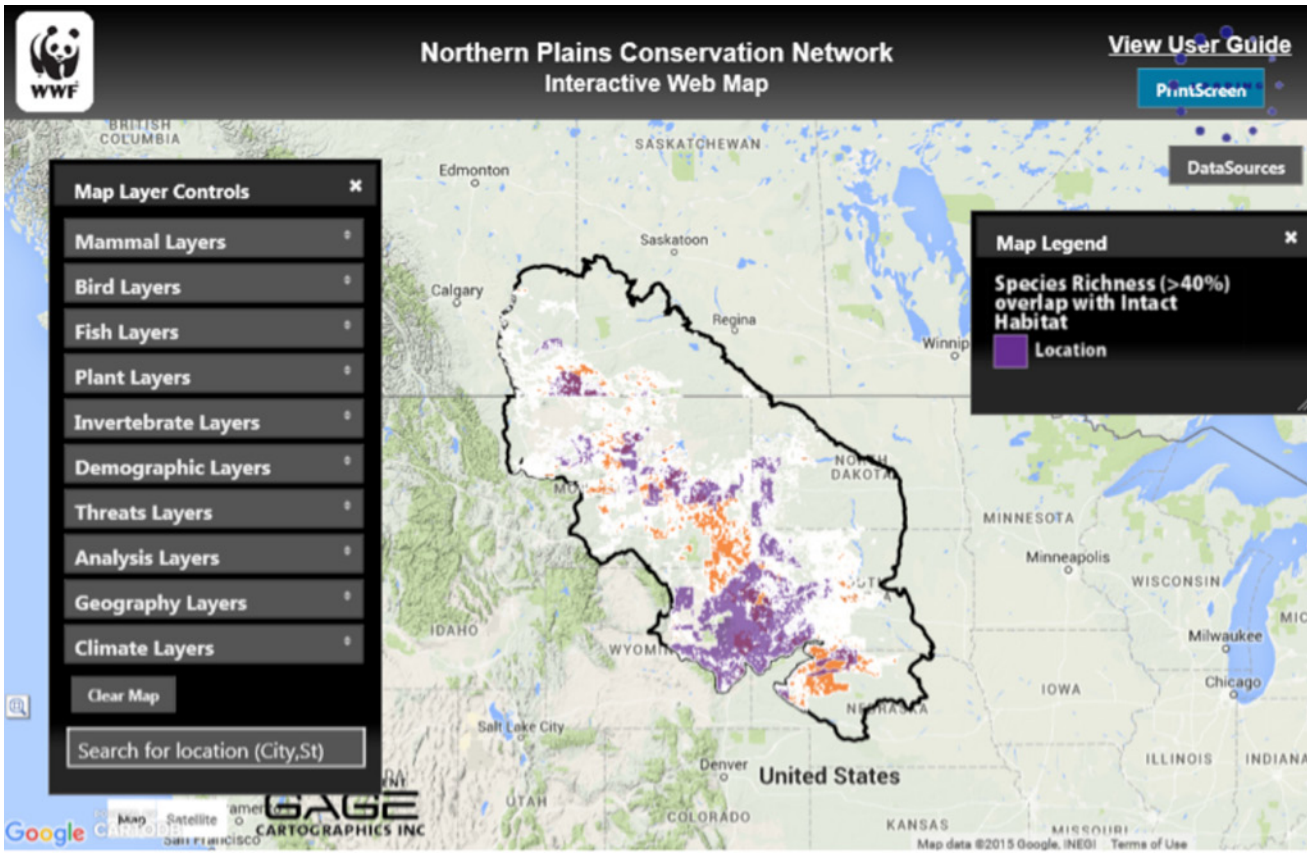
NPCN is supporting the work of many groups involved with bison to: 1) collaborate with and support tribes who want to restore bison to their lands or partner with other government agencies to restore bison across multiple jurisdictions; 2) partner with other private landowners in ecological restoration; and 3) identify and disseminate information on efforts to restore the ecological role of bison and best management practices for grassland management and agricultural practices.

NPCN meetings, website, and monthly bison informational calls have helped to provide information on the conservation relevance of bison to the Northern Great Plains, threats, best management practices, metrics for measuring the success of grassland restoration and impacts on bison on large landscapes. Events such as National Bison Day and public education campaigns such as meetings of the American Bison Society and the International Union for the Conservation of Nature Bison Specialist Group have also increased public awareness of bison.

On NPCN's website is an interactive mapping tool for the Northern Great Plains (www.npcn.net/npcnWebmap/). Data sets include species presence, plants and invertebrates, threats including oil and gas, dams, invasive species, areas of conservation opportunity, grassland conversion and land ownership. Data can be overlaid for quick and easy display and is available for public use.

NPCN meets twice annually in different venues across the Northern Great Plains to provide a wide range of local participants a chance to participate. Invited speakers provide information on timely topics and issues raised at previous meetings. The Fall 2015 biannual meeting was held in Bozeman, Montana and included twenty-one attendees. Tim Seipel, Montana

Example of Web Map with species richness overlay:



State University and John Carlson, Bureau of Land Management (BLM) presented on research and programs on fire as a prairie conservation tool. John Carlson also shared detailed information about where and how the BLM is focusing Greater Sage-grouse habitat management efforts in Montana. The group also heard how various organizations are working with private landowners towards grassland management for a wide variety of species.

The Spring 2015 biannual meeting was held in Douglas, Wyoming. USDA Forest Service representatives and others shared information about efforts to improve the success of Black-footed ferret reintroductions. Information on local issues in Thunder Basin National Grassland was provided through presentations from Laurel Vicklund, Thunder Basin Grasslands Prairie Ecosystem Association and David Augustine, Agricultural Research Service. A field trip offered participants the chance to visit one of the ferret reintroduction sites on Thunder Basin National Grassland. Additional presentations provided meeting participants with information on efforts to expand conservation bison herds, threats to the Pallid Sturgeon and initiatives to produce and market ecologically friendly beef. The attendance and input by a local rancher provided the group with an opportunity to discuss options for compatible cattle and prairie dog management.

NPCN holds three to four webinars a year on various topics. Presenters have included Rick Nelson and Anne Gage. Rick Nelson is the Coordinator for the Plains and Prairie Potholes Landscape Conservation Cooperative (LCC), who provided an overview of the LCC concept and detailed the evolution of the PPPLCC over the course of its nearly five year history. Examples of cross-LCC collaborations were discussed as well as projects that are designed to knit the 22 individual LCCs into a functioning network. Anne Gage of World

Wildlife Fund (WWF), shared that organization's work on "Tracking Grassland Conversion Across the Northern Great Plains", highlighting how the dataset WWF has compiled using National Agricultural Statistics Service cropland data layer, represents an assessment of how much of the Northern Great Plains has been converted to cropland over time. Results of WWF's analysis of grassland conversion are available on NPCN's interactive webmap.

In order to achieve NPCN's vison and mission by informing people, developing opportunities for participation, accessing and providing data and sharing approaches, NPCN employs a wide range of strategies including meetings, webinars, initiative dialogue and a website rich with resources, and information on current events and news. NPCN offers an opportunity for anyone interested or engaged in issues of conservation in this region to get informed and become more involved.

DESERT GRASSLANDS RESTORATION: A SUCCESSFUL COLLABORATIVE EFFORT

Wilma Renken, USDA-Natural Resources Conservation Service

Other Authors: Chase Skaarer, USDA-Natural Resources Conservation Service

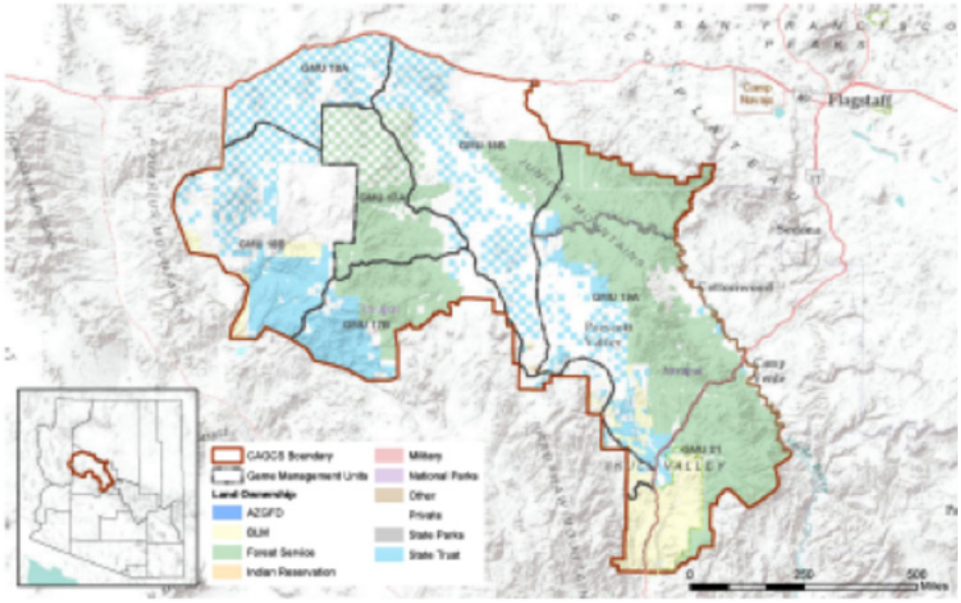
Southeast Arizona is home to unique semi-desert grasslands. Natural fires shaped this landscape into diverse desert grasslands; however, historic land use and fire suppression have led to large expanses of these grasslands becoming shrub dominated. Because of these unique grasslands, the Sulphur Springs Valley is an area rich in wildlife species, and is considered by many to be one of the most biologically diverse areas of North America. However, conversion from grassland to a shrub dominated landscape has adversely affected some wildlife. A few of the species of concern found here are the North American pronghorn antelope, scaled quail, and Sprague's pipet; all of which are identified as declining species. Because of shared resource concerns, several ranchers in the Sulphur Springs Valley realized that through coordination of their individual management strategies, they could effectively restore grasslands and wildlife on a landscape-wide scale. To achieve their goals they pursued partnerships with several federal and state agencies that could help them make this landscape level change.

In 2010, local ranchers, USDA-NRCS, Willcox-San Simon NRCD, Coronado RC&D, BLM, USFWS, AZGFD and Arizona Cooperative Extension successfully received funding for the Bonita Grasslands Wildlife Habitat Incentive Project. To date, local ranchers have been able to directly impact over 20 square miles of historic grasslands. In the areas treated, mesquite canopy cover has been reduced by over 90%, warm season perennial grass cover has increased by 100%, and forage production has quadrupled. The ranchers continue to implement their conservation management plans, and along with their partners continue to monitor conditions and treat mesquite regrowth. The real success story however, is the trust and lasting relationships among partners.

CENTRAL ARIZONA GRASSLAND RESTORATION: COLLABORATIVE PARTNERSHIPS FOR LANDSCAPE-SCALE GRASSLAND RESTORATION

Kelly Wolff-Krauter, Arizona Game and Fish Department

The Central Arizona Grassland Conservation Strategy (CAGCS) was signed (2010) by three signatory agencies to the charter with complementary roles and responsibilities in managing historic grassland ecosystems and/or the wildlife species that inhabit them. The Bureau of Land Management (BLM) management emphasis within the Agua Fria National



Monument (AFNM) is to conserve and restore diverse habitats, vegetative communities and corridors of connectivity to sustain a wide range of native species. The Arizona Game and Fish Department (AGFD) holds the public trust responsibility of managing the wildlife that inhabit these ecosystems. This includes but is not limited to gathering and managing wildlife data, and providing expertise in the implementation of management strategies.

A key grassland species with a high conservation and restoration priority for the AGFD is the American pronghorn. Pronghorn are recognized as a "Priority Game Species" by the BLM. The Forest Service (FS) in the Southwestern Region is operating under the "Central Priority" that emphasizes restoration of fire adapted ecosystems, of which grasslands are a major component. The Forest Service recognizes pronghorn as a Management Indicator Species (MIS) for grassland ecosystems serving as an umbrella species, representative of a whole suite of species with related habitat needs, which rely upon grasslands for all or part of their life-cycles. As an umbrella species, it is assumed that if management actions initiated in grasslands will provide benefit to pronghorn, those same management actions will provide benefit to the other species that make up that suite of grassland wildlife species.

The successes CAGCS depends on commitment and follow through by sponsor agencies and stakeholders to include supporting restoration actions into annual work plans and budgets; as well public support and development of future partnerships with key stakeholders and landowners Implementation of the CAGCS is coordinated by an Interagency Team. The team meets no less than bi-annually (or as agreed upon by the sponsors) to:

- Evaluate progress towards the goals, strategies, objectives and actions
- Incorporate new data about resources and needs into plans
- Identify new projects and funding opportunities
- Prioritize projects into annual work plans
- Develop and maintain project management and tracking databases to ensure an agile approach to resource conservation planning and implementation

Public participation is recognized as a vital piece to this strategy and projects, and all of the partner agencies are looking for ways to support and encourage this participation. Public participation introduces a range of ideas, experiences, perspectives and expertise that motivate the development of alternative solutions. This in-turn, enhances the knowledge of the people involved in decision-making and implementation of

the projects under the strategy. For the success of the CAGCS, it is important to know what the views and interests of our stakeholders are. For general information and updates, please refer to our blog site: **http://centralazgrassland.tumblr.com/**. We share information and get input from the public at Statewide Habitat Partnership Committee meetings, local Habitat Partnership Committee meetings, Natural Resource Conservation District meetings and other venues (workshops, conferences, etc).

The two main goals of the strategy are to improve the health of the grassland ecosystem and improve populations of wildlife associated with the grasslands. Various objectives, strategies and actions were developed through a collaborative process including: juniper thinning/eradication with various techniques,, prescribed fire, fence modifications to improve permeability for wildlife, wildlife water developments, eradication of invasive species (snakeweed, mesquite, catclaw, etc.), telemetry for movement of pronghorn to identify target treatments and predator management (see the CAGCS for full list of potential management actions **http://www.azgfd.gov/w_c/WildlifePlanning.shtml).**

The Wildlife Habitat Enhancement Initiative (WHEI) was developed (Arizona Game and Fish Department 2014) in response to declines in mule deer and scaled quail. Certainly, habitat components are but one aspect that influences population dynamics, but habitat plays a pivotal role in mitigating the effects of other variables like persistent drought and predation. Game Management Units (GMUs) were identified for focus on mule deer including 21 and 22 in and adjacent to the efforts within the CAGCS.

GMU	Date	Observed
21	1994	342
	1996	276
	1997	259
	1998	125
	1999	85
	2000	166
	2001	57
	2002	80
	2003	59
	2004	117
	2005	57
	2006	85
	2007	75
	2008	97
	2009	135
	2010	88
	2011	128
	2012	191
	2013	202
	2014	274
22	1994	318
	1995	110
	1996	334
	1997	284
	1998	365
	1999	219
	2000	318
	2001	178
	2002	269
	2003	258
	2004	210
	2005	266
	2006	174
	2007	272
	2008	158
	2009	240
	2010	162
	2011	241
	2012	163
	2013	201
	2014	179

CAGCS/WHEI Treatment Methods

The treatment specifications vary somewhat between units across the entire CAGCS/WHEI boundary, but have generally included the following:

- Grassland Treatment: 0-1 trees/acre versus Woodland/Savannah Treatment: 2-5 trees/acre

o "Low Density Grassland" (0-5 trees/acres) and "Medium Density Grassland" (5-15 trees/acre) treatments. Target trees species are Juniper species, Utah juniper *(Juniperus osteosperma)* and one-seed juniper *(Juniperus monosperma)* of varying heights; the majority of which is composed of trees less than 7 feet in height, although the size of trees and densities increase near the edge of project polygons

- Cut stumps as low as feasible; below green limbs; stumps not >15"; stumps of the trees can be treated with a triclopyr (Active Ingredient) based herbicide, immediately after cutting of the main tree bole

- Pile slash on stumps in preparation for burning

- 25% lop & scatter 75% pile; Pile more slash in densely stocked areas; scatter more slash in high erosion areas

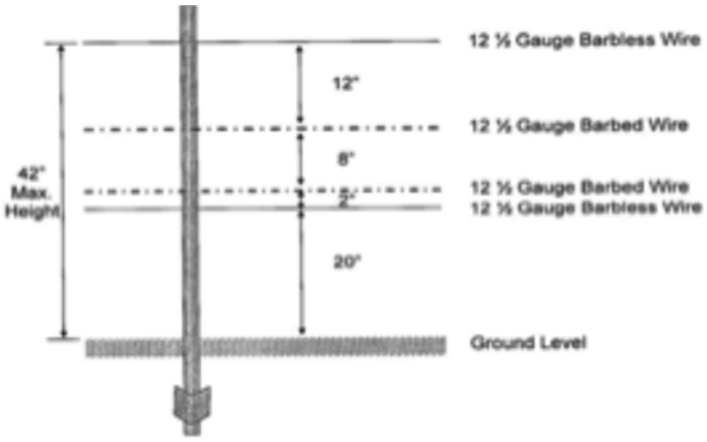
- Reduce slash to not >18" in height and 3" in diameter; scatter broadly; branches >3" should be piled

- In previously treated open areas, small trees < 6 feet tall may be felled and left intact

- Mature (leave tees not for removal) should be limbed to a height 4', removing branches at a height of 4' and below to ground level

- Retain mixed age class; retain healthy tree-form juniper

- Retain good shade trees for livestock and wildlife; retain large snags/monarch trees for wildlife



- Drainage buffers to protect watershed and T&E species associated with perennial streams

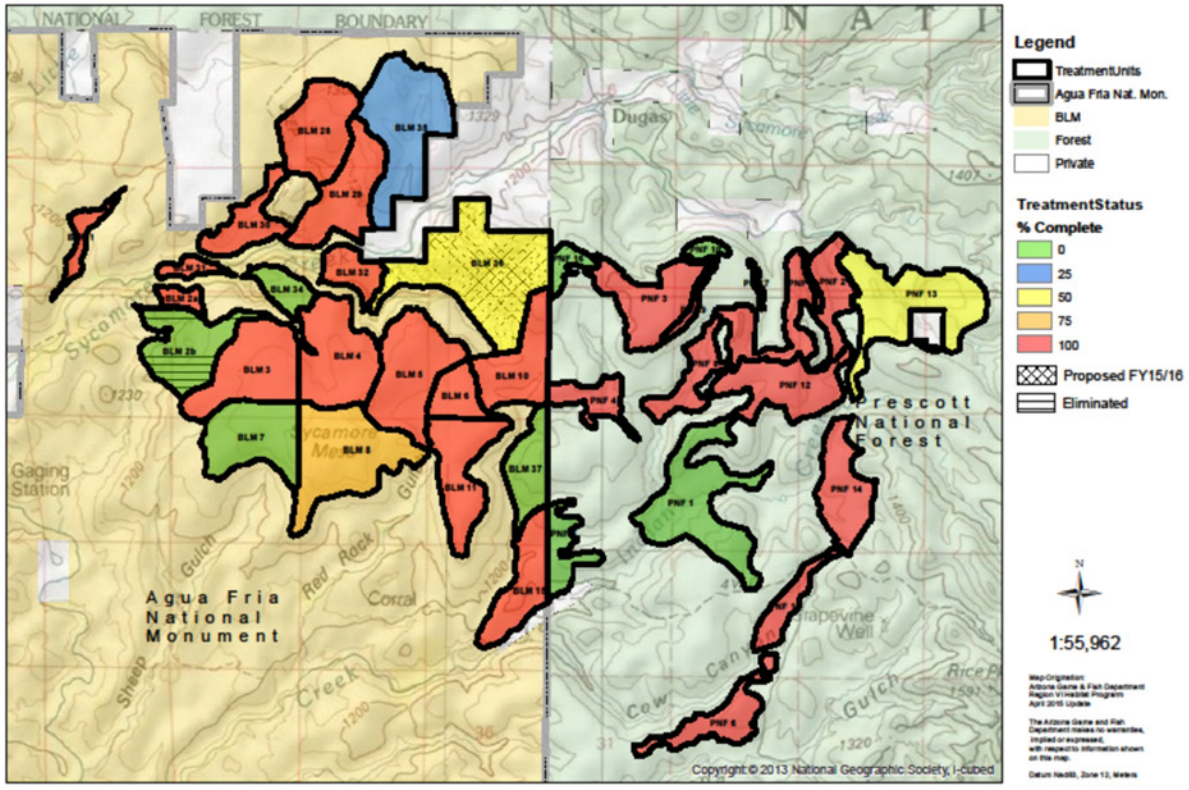
Fence modifications are designed to distribute wildlife and increase permeability for movement and connectivity across the landscape.

Water sources providing year round water 5 miles apart, along with escape ramps for smaller wildlife are evaluated, developed/re-developed as identified within the project area.

Millions of dollars have been spent since 2006 with funding through the Arizona Game and Fish Department. Funding partnerships have also included:

- AGFD Wildlife Conservation Fund
- AGFD Game and Fish Fund
- AGFD Pittman Robinson State Grants for Central Arizona Grassland Conservation Strategy (CAGCS)
- AGFD Pittman Robinson State Grants for Mule Deer Initiative (WHEI)
- AGFD Habitat Partnership Committee: Mule Deer/ Antelope tag funds
- Department of Interior - Healthy Lands Initiative funding (through BLM)
- Bureau of Land Management – annual appropriations from various program budgets
- Prescott National Forest – annual appropriations from various program budgets
- NRCS various grant programs in working collaboratively with landowners and permittees

GMU 21 Sycamore Mesa Juniper Thinning Project (BLM) and Agua Fria Antelope Habitat Improvement Project (PNF)



It is estimated that over 15,254 acres of grassland habitat have been restored and enhanced for wildlife from 2010-2015 alone. We would like to provide an example of a long running project to the North of the Phoenix area on the west side of I-17 within Game Management Unit 21: Sycamore Mesa Juniper Thinning and Agua Fria Antelope Habitat Improvement

The Game Management Unit 21 pronghorn population is considered an isolated population due to the I-17 corridor and topography associated with the Verde River. I-17 separates pronghorn herds between Game Management Unit 21, Unit 19A in the Orme Ranch area, and Unit 20A in the Cordes area. Habitat connectivity between northern and southern high quality pronghorn range in GMU 21 was being threatened by increasing juniper tree densities and invasion on mesas with open grasslands. The BLM had a priority to conduct fuels reduction activities within the area. For these reasons collaborative efforts were set in motion in 2004 between BLM and AGFD, and the project expanded onto the PNF in 2009. This project continues to move forward to date. Today, 65% of the project has been completed, a total of 4268 acres out of a current target of 6796 for treatment. Chainsaw cutting and pile burning of juniper trees has been conducted within prioritized "units" in phases as funding becomes available; 25 out of 37 units have been completed (see summary map). The Arizona Game and Fish Department has invested over $1,087,943 (including $130,000 Department of Interior Healthy Lands Initiative funding from BLM) on juniper thinning contracts to date for this project. The PNF and BLM have invested significant financial resources towards project planning and management, as well as manpower and expertise to conduct the follow-up pile burning. The overall running average cost of treatments is approximately ~$261.00/acre for juniper thinning and ~$49.00/acre for pile burning.

We have provided this overview to share information, gain interest and highlight one of the landscape scale restoration efforts the Arizona Game and Fish Department and partners are committed to for wildlife. As plans continue to develop and are implemented, we hope to continue to share our progress in restoring and enhancing central Arizona grasslands for wildlife. So, in moving forward into the 2015-2016 budget cycle, the CAGCS has been allotted another $350,000 through the Arizona Game and Fish Department and will be implementing ~2,300 acres for treatment (hand cutting for juniper, mesquite eradication and fire), provide funds for further development of our geospatial decision support tool and convert a well to solar. The BLM, PNF and NRCS will continue to provide funding for treatment efforts. In addition, the Implementation Team will continue to request and pursue additional funding sources.

THE LESSER PRAIRIE CHICKEN RANGE-WIDE CONSERVATION PLAN: A NEW PARADIGM IN WILDLIFE MANAGEMENT

William E. Van Pelt, Western Association of Fish and Wildlife Agencies

Since the 19th century, Lesser Prairie-Chickens (*Tympanuchus pallidicinctus*; LPC) and their associated habitat have diminished across their historical range, which included parts of Texas, Oklahoma, Colorado, Kansas, and New Mexico (Taylor and Guthery 1980a). Recent estimates of current occupied range total ~80,000 km2 (30,900 mi2), or ~17% of the estimated area of their historical range (figure 1), although boundaries of this estimated range include many areas that are unlikely to be occupied, including riparian corridors, forests, and desert. This reduction in occupied range is primarily attributed to habitat loss and fragmentation (U.S. Fish and Wildlife Service 2012 [USFWS]). Habitat losses have been caused by conversion of native prairie to cropland in the western portion of the range (Taylor and Guthery 1980b), and long-term fire suppression (Woodward et al. 2001) leading to tree invasion (Fuhlendorf et al. 2002) in the eastern portion of the range. Degradation of remaining habitat is due to fire suppression (Woodward et al. 2001, Jones 2009), grazing management practices (Taylor and Guthery 1980a, Riley et al. 1992), and herbicide spraying for shrub control, all of which can reduce the quality of LPC habitat (Thacker et al. 2012). In addition to habitat loss and degradation factors, existing habitat has been fragmented by oil and gas development (Hunt 2004) and possibly also by effects of wind-energy development (Pruett et al. 2009). In addition, LPC populations have been influenced by fences and utility lines (Wolfe et al. 2007, Hagen 2010), prolonged drought (Merchant 1982, Lyons et al. 2011, Grisham 2012), and climate change (U.S. Department of Agriculture Natural Resources Conservation Service 2012, USFWS 2012).

In April 2012, the five wildlife agencies found within LPC range met with the U. S. Fish and Wildlife Service to discuss the feasibility of developing a comprehensive conservation plan with enough effort implementation to influence a not warranted listing decision under the ESA. After this meeting, the states tasked the LPC Interstate Working Group to draft a scientifically-based conservation plan, initially without state boundaries, that would meet the USFWS's Policy for Evaluation of Conservation Efforts (PECE).

An initial stakeholder scoping meeting on the revision of the CHAT and the development of the RWP was held in in Edmond, Oklahoma on June 11, 2012. More than 90 stakeholders representing oil and gas, wind energy, transmission, agriculture associations, Farm Bureau representatives, departments of transportation, public utilities and public utilities commissions, oil and gas permitting agencies, agricultural and natural resource agencies, conservation bankers and conservation organizations attended from across the five state region. A first draft of the RWP titled *Range-wide Conservation Plan for the Lesser Prairie-Chicken* was

provided for public input in January 2013. Input was received at a public meeting held in Edmond, Oklahoma on January 23 and 24, 2013 and was also received through both email and written inputs. A second draft of the RWP was provided for public comment in February with a third draft provided to the USFWS and placed on the WAFWA website for public comment on April 1, 2013. The IWG solicited comments on the third draft of the RWP until May 15, 2013 and the USFWS closed their comments on June 21. Comments were reviewed by the IWG and the current RWP titled *The Lesser Prairie-Chicken Range-wide Conservation Plan* was drafted in October 2013. Finalization and endorsement of the RWP from the USFWS is anticipated in late 2013.

A critical component of RWP development was coordination among the various agencies, organizations, industries, landowners, and other stakeholders interested in LPC and its conservation strategy. Coordination was needed at multiple levels including interagency coordination for federal agencies, interagency coordination within and among states, interagency coordination between states and federal agencies, coordination with regional organizations and industries, intrastate agency and organization coordination, and general outreach and engagement of landowners and the public. Sequencing of planning components involved establishment of various committees to accomplish specific tasks, and then engaging broader involvement as various components of the RWP were available for review and input.

A significant focus of the RWP is the improvement of habitat for LPC on private lands as well as integration of the limited amounts of public land that can contribute to LPC habitat needs. A variety of conservation initiatives focused on improving LPC habitats have been initiated by numerous agencies and organizations. Most of these initiatives are administered at state levels, either through staffing of federal programs at state levels, state agency programs, or organizations that either operate within a state or align with state-level initiatives. For this reason, coordination of LPC programs was woven into the RWP enhancing conservation efforts.

USFWS defines biological goals as the broad, guiding principles that clarify the purpose and direction of the conservation components for conservation tools (65 FR 35241). The biological goals and objectives are designed to address the potential impacts of the proposed activities while taking into account the overall conservation needs of LPC and its habitat. In general, the biological goals will be accomplished by: (1) conserving LPC and their habitat in the service areas, and (2) mitigating the impacts of take contemplated by the RWP by conserving and managing certain known LPC habitat areas throughout the service areas. In addition to these general objectives, the RWP will include a conservation strategy that will strive for the implementation of activities providing the blueprint toward speedy recovery and delisting.

The RWP describes a conservation strategy, which when implemented, will provide the population and habitat needed to expand and sustain LPC. The strategy identifies a desired population goal deemed adequate to provide for a well distributed LPC population dispersed throughout each of four ecoregions within a 10-year period. To meet the population goal, the RWP identifies habitat goals that provide for good representation of adequately sized habitat patches to provide for resiliency in populations, and with enough patches to provide for redundancy to support populations that persist in the long term. The RWP also identifies needed connectivity among habitat patches that will allow for genetic and demographic support among populations and will allow for potential movement of the species given uncertainties from climate change. The RWP provides for coordination and enhancement of programs to improve habitat on private lands through landowner incentive programs, and promotes the avoidance and minimization of impacts to important habitat patches. Where avoidance and minimization is not possible, the RWP identifies processes to mitigate impacts from developments. Finally, the RWP requires monitoring and adaptive management actions.

A key component of the conservation strategy is applying the concept of focal (core) areas. This concept as applied to LPC is based on identifying the areas

of greatest importance to the species, and focusing habitat enhancement, maintenance, conservation, and protection in these areas. In addition, a subset of lands within focal areas will be identified as "strongholds." These are areas meeting the definition described by the USFWS (2012b) and are a much smaller component of focal areas but have the ability to provide permanent LPC conservation areas. This accomplishes:

It concentrates limited resources for species conservation in the most important areas, allowing for the restoration, enhancement, and maintenance of large blocks of habitat needed by LPC. It identifies areas where development should be avoided, which also helps identify areas where development is of less concern for LPC. This provides developers with the guidance they typically seek for their development planning purposes and helps avoid conflicts over impacts to the species.

The conservation strategy employs various tools to achieve its management objectives with an emphasis on focal areas and connectivity zones. With the exception of New Mexico, over 95% of the current LPC range is on private lands. To be successful, the conservation strategy must emphasize delivery of habitat improvement in focal areas and connectivity zones by maximizing incentives to encourage landowners to engage in LPC habitat improvements. This has to be either economically neutral or economically advantageous to the landowner. The strategy identified existing programs available to help provide these improvements and then worked with implementation teams and others to identify how to coordinate and maximize the delivery of these programs, especially in focal areas. Another important component of the strategy is identifying approaches and tools to avoid, minimize, and compensate through off-site mitigation the potential threats to LPC. This is accomplished through a mitigation framework that offers assurances for continued operations for developments in the future following identified guidelines and standards. This mitigation framework includes a metric system to quantify impact units and mitigation units.

The WAFWA Mitigation Framework incentivizes avoidance and minimization of impacts to LPC habitat from development. The metrics system within this framework provides a pathway to mitigate for impacts to habitat through a biologically-based system that incorporates space, time and habitat quality to define both habitat impact units and habitat offset units. A habitat impact is defined as: potential LPC habitat that has been rendered unusable by LPCs based on direct or indirect habitat loss related to development. A habitat offset is defined as: an area of potential LPC habitat that is conserved and managed or restored to compensate for impacted habitat. Impacts are considered permanent, unless remediation back to baseline occurs. The mitigation system also utilizes a 2:1 mitigation ratio to ensure that offsets are greater than impacts, resulting in a net conservation benefit for the LPC.

The WAFWA Mitigation Framework functions as a platform to balance impact and habitat offset units in that a portion of the offset units are allocated at the sign-up based on current acreage and habitat quality. Additional offset units are generated annually and the quantity is reflective of potentially usable acreage and habitat quality. The landowner is incentivized to manage for quality habitat because their annual payment is based on the acreage and Habitat Evaluation Guide (HEG) score of the enrolled property. If the participant does not follow the recommended management plan for the property, the offset units will be reduced, as will the annual payment to the participant. This performance-based system ensures participants are not paid in advance for ungenerated offset units.

Offset units will be generated by enrolling a property into an agreement with WAFWA or one of its technical service providers. Participants may enroll in short-term (5-10 year) agreements or in long-term agreements requiring an easement. The value of 25% of the habitat offset units will be targeted towards permanent conservation to support long-term or dynamic conservation and population strongholds. The remaining 75% of the conservation efforts will be targeted towards short-term or static contracts (5-10 years), which represent permanent conservation that

may shift around on the landscape within the targeting goals of the RWP and the CHAT. Finally the WAFWA mitigation system incentivizes the remediation of impacts that are not permanent on the landscape by providing the opportunity to generate offset units that can count toward new developments elsewhere. The 25/75 ratio of long and short-term offset units will be evaluated through the adaptive management process and may need to be adjusted in the future.

The RWP establishes a mechanism to enroll private or state lands to produce conservation benefits to LPC by implementing management practices that will improve habitat quality and quantity. Offset units will be generated by enrolling a property into an agreement with WAFWA or one of its technical service providers. A property must be at least 160 acres in one block to be eligible to produce offset unit. This eligibility requirement is to ensure that habitat is being managed at a sufficient size to provide a meaningful benefit to the species. Multiple landowners may cooperate to produce a management area meeting the size requirement. The property must be managed in compliance with a WAFWA-approved management plan to generate offset units. Each year a property is in an agreement, it will generate offset units based on the LPC habitat quality and the acreage of unimpacted by development. This system is performance-based which means higher quality habitat generates more offset units per acre. This will result in higher payments for landowners who manage their property well. The maximum rate that offset units may be generated is 1.25 units per acre per year where the HEG score is equal to one and the property falls within a focal area.

The first landowner application for a term contract was received by WAFWA on November 14, 2013. From that date until the end of this reporting period a total of 48 applications were submitted. Through those applications, landowners offered 309,154 acres with the greatest amount coming from the mixed grass service area.

Adaptive management is defined as a formal, structured approach to dealing with uncertainty in natural resource management, using the experience of management and the results of research as an ongoing feedback loop for continuous improvement. Adaptive approaches to management recognize that the answers to all management questions are not known and that the information necessary to formulate answers is often unavailable. Adaptive management also includes, by definition, a commitment to change management practices when deemed appropriate within the guidelines of the RWP.

Adaptive management is a dynamic process that helps reduce uncertainty in natural resource management by incorporating into flexible conservation plans new information as it becomes available. Adaptive management strategies allow for mutually agreed-upon changes to the conservation measures to occur in response to changing conditions or new information, including those identified during monitoring. The primary reason for using Adaptive management in the RWP is to allow for changes in the conservation measures that may be necessary to reach the stated long-term goals. Under adaptive management, the mitigation and conservation activities implemented under the RWP will be monitored to identify whether or not they are producing the required results. Additionally, adaptive management activities affecting the implementation of the RWP will be influenced by emerging science that fills existing knowledge gaps. Those two types of information will be used to guide adjustments in implementation of the RWP.

While impact acreage is important, it is only part of the mitigation framework under the RWP. This framework utilizes habitat units, which include both acreage and a proportional habitat quality such that one acre of the highest quality habitat equals one unit. If the habitat quality on that acre falls to 0.5, then the acre accounts for a half a habitat unit. For impacts the habitat quality is assessed prior to impacts, and a company can significantly reduce mitigation costs by avoiding high quality habitat for development in favor of lower quality habitat. Those impacts must be offset with iterative short-term conservation contracts or permanent easements at an average 2:1 mitigation ratio and those offsets use the same system of habitat units based on acreage and habitat quality.

Figure 1. Estimated historical range and current occupied range of Lesser Prairie-Chickens.

The first landowner application for a term contract was received by WAFWA on November 14, 2013. From that date until the end of this reporting period a total of 48 applications were submitted. Through those applications, landowners offered 309,154 acres with the greatest amount coming from the mixed grass service area. Prior to the end of the 11 contracts had been offered to landowners across the LPC range. Those offered contracts contained 68,874 acres with the majority located in the mixed grass service area.

Overall, the RWP allowed for economic development to continue in a seamless manner by providing an efficient mechanism to voluntarily conserve the LPC and/or comply with the ESA. Without the RWP, there could have been significant regulatory delays in obtaining take permits, disruption to economic activity in an area vital to state and national interests, and little incentive to conserve LPC habitat on private lands. The RWP encourages participants to enact proactive and voluntary conservation activities promoting LPC

conservation. Implementation was tracked through a committee structure using adaptive management. Goals and objectives associated with population levels, habitat conservation objectives, and funding streams were conducted by the adaptive management process.

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4. GRAZING AND GRASSLANDS MANAGEMENT

CHANGE: IT'S NOT A FOUR LETTER WORD

Cody Sand and Deanna Sand, Producers - North Dakota Grazing Lands Coalition

History

We began leasing our 3rd generation ranch, from Deanna's parents, in 1999. In 2001 we had the opportunity to purchase it. We live on the ranch with our 3 children, Bailey, Desa and Baxter. We ranched conventionally, this included: calving heifers in March and cows in April, putting up about 2000 round bales of hay each summer, weaning and backgrounding our calves prior to selling them. Deanna worked off the ranch driving 60 miles to work each day and Cody made custom saddles to supplement the ranch. We leased an additional 1300 acres from an out-of-state landlord. The land was leased for 10 years; we had the opportunity to purchase it in 2013. We refer to this as "The OP" (other place).

Catalyst for Change

In 2010, after selling our backgrounded calves we still had $20,000 in unmet obligations/ carry-over bills. We were told "you'll have to borrow more money next year". Our thoughts were how can we sell the same amount of calves next year and borrow MORE money. It was at that point we had the opportunity to read a book by Dave Ramsey "Total Money Makeover" and shortly after took a Holistic Management Class in Bismarck, ND taught by Joshua Dukart. The class was 3 days of incredible paradigm shifts and excitement. We wanted to become profitable and try to be debt free.

Decrease Debt

We weren't able to come home and change everything immediately as the class was in January and our cows were already bred for April calving. We did decide we were going to change a lot of things on our ranch. We began by selling everything we could, bale feeders, turned tire feeders, V-Rake, calf shelters, grinder/mixer, any junk or wire we could find to pay down as much debt as quickly as we could. One more calving season was enough to keep us really focused on not turning the bulls until August.

Manage the Whole

We now manage our ranch as a whole instead of individual parts. When we began changing our ranch we realized every decision we made affected something else. Some benefits or challenges might not be noticed for up to a year later. At that point we can decide to do nothing, or change again. Our holistic goal included being low input and high profit to improve quality of life. So returning to how we "always" did something usually isn't an option.

Summer Grazing

The first thing we changed was our summer grazing program. We use to run 3-4 groups of cattle with minimal rotation. After the HM class we realized that by keeping 1 large group of cattle we are able to take advantage of higher stock density planned grazing. Our CRP contract was expiring, we did not re-enroll the 400 acres, but began to strip graze this land. The land had been rested for 15 years; it had a thick spongy mat of dead grass and was not productive. We managed this by using temporary fencing. This was somewhat labor intensive and we couldn't get the impact we desired due to not having adequate water sources. We were fortunate to enter into an EQIP contract with our local NRCS office. With the help of that project we went from 15 paddocks to 65 paddocks, which are roughly 40 acres each. We dug in deep pipeline and added large rubber tire water tanks. Since adding this infrastructure we have noticed several benefits.

By planning our grazing, we have been able to increase our stock density. We have more cattle in a smaller area for less time. We graze roughly 250 head in 40 acres for 2-5 days. The amount of time spent in each paddock is dependent on several factors. We observe the cattle and remain flexible. We have observed:

1. More evenly grazed pastures

2. Increased grazing days - for example: when renting the OP (1300 acres) we were held to a set stocking rate of 180 pair for 5 months this equals 29 grazing days/AC; after changing our management we have better utilized the land and have improved to 63 GD/AC

3. Trampling and leaving a litter mat - this has improved water infiltration and decreased run-off and evaporation

4. Increased rest and recovery time - by grazing entire herd in one paddock we have a lot of impact then we can rest that paddock for up to 365 days or longer

5. Decreasing what we don't want - we have decreased Kentucky Blue Grass invasions by grazing early and giving other plants a chance to grow and thrive

6. Increased soil health - our soils are healthier and active our native plant population has increased, especially warm season grasses and forbs

7. Improved wildlife and insect population - ducks, deer, spiders, dung beetles, frogs and monarch butterflies have been observed in new areas

Winter Grazing

We have been winter grazing our cattle on rented crop aftermath for about 10 years. We truck our cattle about 40 miles east of our ranch. We developed a relationship with a farmer who used to have cattle. He enjoys seeing them come in the fall and heading home in the spring. We have limited expense in winter grazing. We do however have labor in the fact that we graze roughly 1500 acres of corn which we fence every year. He rotates crops, so we don't have the ability to graze the same area every year and he prefers fenced be removed each spring. Our cattle are minimally supplemented; they have become very savvy grazers even when the conditions get tough. We didn't fully realize the benefit of winter grazing until we changed our calving date.

Calve with Nature

Our cattle are bred to begin calving in June. They come home from corn stalks in April and go directly to pasture that wasn't grazed the previous year. By having this stockpiled grass we are able to have our cattle grazing 12 months of the year. Since our cattle are not in their 3rd trimester while being on the cornfield, they require less feed. When they arrive home they begin their 3rd trimester on good quality forage when their nutritional requirements are at their peak. Our cattle calve out on pasture. This has decreased stress on our family and on the cattle. We have healthier calves. Scours and pneumonia are not something we worry about and we don't have to leave the house in a blizzard.

Less Hay

We have all but stopped making hay. The summers used to be filled with haying. We generally made 2000 big round bales every year. We fed hay from March to May. Now we have decreased input and time in making and feeding hay. Our cattle graze all year. We supplement with some purchased alfalfa, if needed, when they are on corn stalks. When the cattle arrive home on pasture in the spring we can supplement with range cake. We have greatly decreased machinery and fuel cost by not making or feeding the hay.

Marketing Small Calves

In calving later we have also changed our marketing of calves. We retain heifers and sell steers directly off of the cow. In calving later, and not backgrounding our steer calves, we are selling considerably smaller calves. By having very minimal input expense in raising the calves we can sell them at a lower weight and meet all our obligations.

Weaning Calves

We do leave the heifer calves on the cow all winter. They learn how to graze from their mothers. Keeping them on their mother until 10 months of age also helps in the development of their rumen. We wean the heifers in March and bring them home to stockpiled pasture. By not feeding heavy and "roughing" our cattle in the winter, we did notice our young cows (i.e. bred as yearlings) were not holding their weight as 3 year olds especially with a calf on their side most of the year. We had 2 options to fix this problem. 1.feed more (inputs were not an option) or 2.breed the heifers at 2 years of age. We chose option 2 and this summer was the first year of calving the heifers at 3 years of age. They are in phenomenal shape. The calves are bigger and healthy. Going into the winter the 3 yr. old cows have maintained their body condition and have weight they can afford to loose over the winter since they won't calve until June. We are excited to see the longevity of these cattle in the future. They have never been fed in a lot and pasture bred with a 3% open rate.

Quality of Life

We have changed a lot since taking the Holistic Management class. We have had to adapt knowing that going back to how we used to do things just isn't an option. We are enjoying our quality of life. Deanna is not working off the ranch anymore. We are almost debt free, except our land loan. We can make decisions on our ranch without any other entity telling us what to do.

RESTORING THE HEALTH OF THE SAGE-STEPPE ECOSYSTEM

Dr. Terry Z. Riley, North American Grouse Partnership

One of the largest ecosystems in the United States is in serious trouble. Historically covering about 150-million acres, the sagebrush (*Artemisia* spp.) ecosystem is threatened today by conversion to cropland and hayfields, invasive species, incompatible grazing systems, fire suppres¬sion, vehicle traffic, and exurban developments. As a result, large numbers of plant and animal species are imperiled. Conserving and restoring the health of this ecosystem will present significant ecological, economic, political and social challenges. Our study area is located on the High Lonesome Ranch (HLR) in Garfield County in Western Colorado. The topography on the HLR consists of long (5-10 km) ridges at an elevation of about 2,500±200 m and valleys at an elevation of about 1,800±200 m. We conducted our study on Kimball Mountain, a semi-arid ridge at an elevation of about 2,550±50 m. Kimball Mountain is characterized as a high-elevation mountain big sagebrush-steppe community. Ecological site descriptions identify the area as a Mountain Shallow Loam (Mountain Big Sagebrush) Ecological Site.

The Reference State of an ecological site is a description of the site just prior to Euro-American settlement but long after the arrival of Native Americans. The description of the Reference State for sites similar to Kimball Mountain was determined by NRCS Soil Survey Type Site Location information and familiarity

with rangeland relict areas where they existed. The least modified plant community, the Reference State, for this ecological site should be co-dominated by mountain big sagebrush and bluebunch wheatgrass with a rich herbaceous understory. Dominant shrubs expected in the least modified plant community would include mountain big sagebrush and Utah serviceberry. Dominant grasses include bluebunch wheatgrass and Sandberg bluegrass. Dominant forbs include silverleaf milkvetch, arrowleaf balsamroot, and longleaf phlox. The purpose of our study is to examine the health and condition of the existing ecological site and to provide information necessary to restore the area to its Reference State. Once the Reference State is restored, then animal species, such as the greater sage-grouse, should find most, if not all, of their life requisites for successful survival and recruitment.

EVALUATION OF INCREASED VEGETATION COVER IN GRAZING LANDS THROUGH HOLISTIC MANAGEMENT ON A CATTLE RANCH IN EASTERN COLORADO

Teresa Chapman, The Nature Conservancy

Other Authors: Chris Pague, John Sanderson, Terri Schultz, The Nature Conservancy

Maintaining and improving grassland productivity, ranchland economic viability, and biodiversity provide the foundation for sustainable adaptive grazing management plans. On a cattle ranch in eastern Colorado, The Nature Conservancy has worked together with the ranch owner to implement sustainable grazing management plans since spring 2012, including the construction of numerous fences for rest and rotation practices. In this analysis, we evaluate the influence of change in management plans to remotely sensed greenness vegetation index in relationship to a study area of neighboring ranches with unaltered, more continuously grazed management plans. We hypothesize that sustainable grazing management planning will lead to increased shortgrass prairie and sandsage shrubland greenness. Satellite image derived vegetation indices have previously been closely correlated with grassland productivity. We use a 30-m Landsat time series of soil adjusted vegetation index (SAVI) to measure differences in pre- and post-sustainable grazing management plans. We first use 1m NAIP imagery with four bands to classify major land covertypes (shortgrass prairie, sandsage shrubland, riparian woodland, and bare ground) within the study area and use this classification to categorize Landsat pixels into each land cover type in order to analyze different land cover classes separately. We then compare before and after normalized SAVI values for each landcover group on the ranch where we have changed management in comparison to the entire area of neighboring ranches.

This analysis tests our hypothesis that carefully planned grazing management increases grassland productivity as detected in a remotely sensed vegetation index. Providing quantitative evidence of increased productivity following implementation of adaptive management is a top science priority in building the case for widespread adaptation of sustainable grazing practices across eastern Colorado.

Photo credit: Aviva Glaser.

IMPROVING GRAZING PRODUCTION AND WILDLIFE HABITAT IN THE EASTERN TALLGRASS PRAIRIE REGION WITH FEDERAL, STATE, AND LOCAL PROGRAMS; THREE LANDOWNER SUCCESS STORIES IN MISSOURI.

Ryan W. Diener, Pheasants Forever

Other Authors: Polly Sachs, Montgomery and Warren County Soil and Water Conservation District; Sarah Szachnieski and Tammy Teeter, Natural Resources Conservation Service

Native grasses, wildflowers and forbs were once plentiful across Missouri's landscape. During European settlement, over 15 million acres of lush prairie grew abundantly across the state. Early pioneers realized the benefits of native grasses for hay production and forage for livestock; however, Missouri's native prairies quickly became stressed due to over utilization. Natives were slowly replaced with non-native cool-season grasses such as orchardgrass *(Dactylis glomerata)* and timothy *(Phleum pratense);* and later, landscape scale conversion to tall fescue *(Schedonorus arundinaceus),* thought to provide better forage value and longer grazing seasons. Today, less than 1% of Missouri's native prairies remain, however the value of re-incorporating native warm-season grasses back into livestock operations is gaining momentum.

Native grass species such as big bluestem *(Andropogon gerardii),* little bluestem *(Schizachyrium scoparium),* indiangrass *(Sorghastrum nutans),* switchgrass *(Panicum virgatum),* and eastern gamagrass *(Tripsacum dactyloides)* are five species commonly selected for warm-season native grass plantings. Moreover, producers are turning towards diverse native plantings that include native cool-season grasses like Virginia wildrye *(Elymus virginicus)* and river oats *(Chasmanthium latifolium),* and a diverse forb component with these native warm-season grasses.

Missouri cattlemen are showing an increased interest in diversifying their grazing using native species. Many of our constituents are not aware of the opportunities available to them through cost share programs to help make this type of transition in their operations. We will explore three landowner success stories of converting fescue pasture and cropland to native pastures using federal, state, and local cost share programs in East Central Missouri. We will also discuss the importance of buy-in of local landowner groups and partners in working with livestock producers and native vegetation forage.

Landowner A used a long term plan to accomplish his goals of increasing native forage in his production cycle. Planning began 12 years ago when he enrolled 25 acres into the Conservation Reserve Program CP-2 practice. Those crop acres were converted to a stand of native warm season grasses and forbs, and were periodically grazed during the CRP contract as allowed by the program rules. When the contract was set to expire, Landowner A signed up for The Environmental Quality Incentives Program to get paddock fencing and water set up on the expiring CRP acres to prepare it for his grazing rotation in the future. Using these two federal cost share programs, Landowner A was able to increase his summer forage production without having to initially lose grazing acreage or reduce the number of cattle. The planting and improvements had been long paid for between the CRP payments and cost share by the time the area was put into his grazing rotation. The landowner has since also converted several acres of fescue infested savanna back to native grasses through the Conservation Stewardship Program that he can also flash graze as part of his rotation now. Grass production, average daily gains, and weaning weights have all increased for the landowner, dramatically improving the profit margin for the operation.

Landowner B had an area of pasture that had been slowly increasing with eastern red cedars. He wanted the area to be more productive for his cattle, but he also wanted to have some quality wildlife habitat,

specifically for Northern Bobwhite Quail. Using the Habitat Challenge Grant Program, a jointly funded cost share program through the Missouri Department of Conservation and Quail Forever, the landowner was able to get assistance in making this work. Cost share was available to help clear the cedars, spray out the fescue undergrowth, and plant a diverse mix of native grasses and forbs. The area was sprayed after the first hard frost, as it was a remnant of unplowed ground in the prairie region of East Central Missouri. This allowed for a spraying that would kill fescue but not harm any of the remnant native plants in the area. Landowner B completed a late spring seeding that was met with some timely rainfall. By the end of July the first growing season, nearly all species could be accounted for in the seed mix. Light grazing of the area was done in the second growing season. Full grazing was available in the 3rd growing season. By using a high diverse, ecotype mix, the landowner got 90% cost share for the seeding, and was in the black on those acres through production by the end of the second year.

Landowner C had learned about the idea of including native grasses in his pasture system while attending a local Prescribed Grazing School host by the Soil and Water Conservation District and The University of Missouri Extension. He approached me about doing a conversion of some of his fescue pasture to native grasses. He needed a strategy to still get some grazing from those acres though. Using Quail Forever Chapter cost share, we planned to spray out 21 acres of fescue in September after a hard summer grazing. Those acres were planted to winter wheat immediately following the spraying. The wheat cover crop provided some grazing in the winter months on what had sprouted up. After getting some rest in February and March, Landowner C put his entire herd on the wheat acres in the month of April. The cows did very well on the thick new growth of wheat, Landowner C even commented that he had "never seen (his) cows so fat and happy at the end of April." After this heavy grazing, the area was sprayed with a glyphosate/Plateau mix to kill any wheat and fescue left and keep annual weed

Photo Credit: Ryan Diener, Landowner B with me in the field 12 months after seeding. Happy with the results.

Photo Credit: Ryan Diener, Cattle from Landowner A.

competition down during the establishment year. The native grasses were seeded in May. By the 2nd growing season, the stand was sufficient enough to support moderate grazing.

Other programs that can provide excellent opportunities for incorporating native forages include RCPP, CSP, Grasslands CRP, USFWS Partners Program, and other unexplored state and local programs. The possibilities are out there to help make these systems a reality, we just have to help connect the producers with those potential pools of funds.

All three of these landowners saw very rapid development of their stands. Some cases may take three or four years to get established enough to support regular grazing. Climate and soils can have a large effect on this. It is important to note that I have not experienced complete stand failures, just differing lengths in time it takes to get an established stand. There is a misconception that these native plants are hard to grow, when in reality, we are just not used to growing herbaceous plants that take more than a few weeks to germinate. Patience is key in these projects, and the landowners need to be aware of this up front.

Interest and level of education in local landowners is key to getting these projects off the ground. Both of these are more easily accomplished with willing partners that can help you get the message out there in a unified manner. As a wildlife biologist, I leaned heavily on my local NRCS and SWCD partners to help get initial interest from individuals and put on workshops with these agencies in order to get myself in front of the cattle producers in the area. A good working relationship with local and state Cattleman's Associations is also very helpful. By surrounding myself with people that the local producers already knew and trusted, whom were giving the same information as me, helped me gain the trust of these producers much more quickly. Also, as a biologist, we must learn to speak their language (that of the cattle producers). Talking about average daily gains, tonnage of forage production, and crude protein percentages will get you much further than "we should do this because it is better for wildlife." It is inherently better, we know this, so it doesn't have to be a selling point, and in some cases will even completely turn off producers. We must learn the lingo of their world, and make sure we are living in that realm when working on these types of projects.

Photo Credit: Erik Glenn

GRASSLAND CONSERVATION FROM ONE GENERATION TO THE NEXT. HOW CONSERVATION EASEMENTS ARE WORKING FOR RANCHERS ON THE EASTERN PLAINS OF COLORADO.

Erik Glenn, Colorado Cattlemen's Agricultural Land Trust

The Eastern Plains region of Colorado is dominated by some of North America's most intact grassland prairies. In 2001, the National Fish and Wildlife Foundation (NFWF) concluded that native prairie ecosystems comprise less than three percent of their original acreage in the United States making prairie ecosystems one of the most threatened ecosystems in North America. Increased commodity prices and renewable fuels standards have incentivized landowners in the prairie regions across the United States to convert native grasslands to row crops. Further complicating matters is that prairie conservation is difficult and traditionally less appealing to conservation funders.

In Colorado, grassland conservation is difficult for several reasons, including but not limited to, (1) lack of a significant population base; (2) increased commodity prices which have driven up land values for agricultural purposes and created incentives for landowners to engage in sodbusting; (3) lack of understanding of the threats to the region and its ecological importance; and (4) various financial issues (i.e. conservation easements often do not reduce land values by an amount that makes conservation a viable option). However, interest in conservation within the area is at an all-time high.

This presentation explored the issues related to use of easements in prairie landscapes and discuss the strategies that the Colorado Cattlemen's Agricultural Land Trust (CCALT) has developed to achieve significant conservation successes. The presentation provided multiple case studies to show how strategies developed by CCALT have been implemented in practice.

INFLUENCE OF FIRE, GRAZING AND DROUGHT ON CATTLE HERBIVORY, ENDOPHYTE INFECTION, AND ALKALOID CONCENTRATION OF TALL FESCUE INVADED GRASSLANDS

John Derek Scasta, University of Wyoming

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Invasion of exotic C3 grasses has been documented in many North American grasslands. In particular, tall fescue *(Schedonorus arundinaceus)* is becoming an increasing concern due to the fungal endophyte symbiosis conferring a competitive advantage and specific alkaloids toxic to livestock or wildlife. From 2012 to 2014, we applied patch-burn grazing (burning

a different third of the pasture each year) or complete pasture burning with two years with no fire (burned in 2012 but not in 2013 or 2014) to tall fescue invaded prairies. We measured endophyte infection, ergot alkaloids (ergovaline and ergovalinine), loline alkaloids (N-acetylnorloline, N-acetylloline, and N-formylloline) of fescue tillers. We also measured toxicosis in cattle using fecal chromatography to detect ergovaline. Prescribed fires were conducted in late winter/early spring and grazing was seasonal from May to October. Patchy fires did not alter endophyte infection or alkaloid concentration at the pasture scale over the three year period and the results were confounded by drought. Specific alkaloids did display a differential response to time-since-fire depending on treatment but endophyte infection did not display a time-since-fire response. Ergot alkaloids were highest in the drought and fire year but loline alkaloids were the lowest that year with the patch-burning effect less evident. Multivariate analyses of only the patch-burn grazing treatment suggests that the variance in alkaloid and endophyte composition is explained by inter-annual and inter-pasture variation but not time-since-fire. Herbivory of endophyte infected tillers was up to 4x higher in the burned patches than unburned patches. Cattle never had detectable levels of ergovaline when managed with patchy fires (0 herds out of 12 herd*year possibilities) or managed with complete pasture fires (0 herds out of 4 herds in 2012) but some herds did have detectable levels of ergovaline (>100 ppb) in pastures in years managed without fire in the sampled growing season (2 out of 8 herd*year possibilities). This study indicates that patchy fires can be used to increase utilization of endophyte infected tall fescue in discrete patches and overcome other utilization constraints and may affect specific alkaloids but not endophyte infection. Funding came from the Leopold Center for Sustainable Agriculture.

Photo Credit: Derek Scasta , Fescue toxicosis in cattle is a function of vasoconstriction, elevated body temperature, and increased respiration rates. An outward symptom is the retention of the winter hair coat. Note the cow in the bottom image has a red and rough coat compared to the cow in the top image. Cattle were grazing tall fescue invaded grasslands in Iowa.

USING EARLY GRAZING TO CONTROL KENTUCKY BLUEGRASS

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Early season intensive grazing is being tested as a means to control Kentucky bluegrass (Poa pratensis L.), an invasive grass species. Kentucky bluegrass is a perennial cool-season grass that begins growth in the

spring earlier than native species. Its forage quality is high in the spring but decreases through the season, resulting in reduced overall forage quality of the pasture during the summer. Heavy grazing while Kentucky bluegrass is growing actively may shift the balance in the plant community to favor the native species.

Each of six pastures was assigned to one of two treatments: early intensive and season-long grazing. On the early intensive grazing treatment, the pastures were stocked with cattle as early as possible after Kentucky bluegrass greened up (late April) and prior to the three-leaf stage. Cattle were removed when 30 percent of the native species had received some grazing (early June). On the season-long treatment, cattle were placed on pasture mid-May and removed mid-September.

Frequency of occurrence, density and foliar cover of plant species were monitored using nested frames with 50 frames per pasture. Forage production and utilization were determined using the cage comparison method. While clipping plots at peak production, an estimate was made of species percentage by weight.

Forage production was not significantly different between the early intensive and the season-long grazing treatments in 2011, 2012 or 2013 ($P>0.05$). Kentucky bluegrass foliar cover ($P=0.001$) and frequency of occurrence ($P=0.003$) declined on the early intensive treatment during this study, while foliar cover of Kentucky bluegrass increased ($P=0.001$) on the season-long treatment in 2012 and 2013. After three years, initial results indicate that early grazing can reduce Kentucky bluegrass foliar cover and frequency. Removing cattle before the native grasses and forbs have received significant grazing pressure should allow these species to increase in the community.

This study was conducted at the NDSU - Central Grasslands Research Extension Center in Kidder County, northwest of Streeter in south-central North Dakota.

The pastures have been used for a variety of grazing experiments in the past but in recent years had received only light grazing in the summer months. In 2009 and 2010, these pastures were lightly stocked mid-May. Half of the animals were removed in late June or late July, and the rest remained until late September to mid-October. Kentucky bluegrass had become dominant, with foliar cover averaging about 30 percent and frequency of occurrence (in 25-by 25-centimeter frames) averaging 90 percent in 2011 on the sites selected for vegetation monitoring.

Six pastures of about 40 acres each were assigned to one of two treatments: early intensive grazing and season-long grazing. Livestock were not rotated among pastures, and each pasture received the same treatment every year.

Beginning in 2011, 41 to 50 head of cattle were stocked on each pasture in the early intensive treatment as early as possible after Kentucky bluegrass greened up. Cattle were removed when 30 percent of the native species receive some grazing.

On the season-long treatment, 15 to 19 head were placed on each pasture in mid-May and removed between the end of August and mid-September. This corresponded to a moderate stocking rate. The actual stocking rate was between 0.96 and 1.85 animal unit months (AUMs)/acre.

Changes in the plant community were monitored by sampling the frequency of occurrence, density per unit area and foliar cover of the approximately 97 plant species. Nested frames were placed along a transect, with 50 readings per pasture.

Fortunately, we began monitoring these same parameters on these sites in 2009 in connection with a previous experiment, although the stocking rates were much lower during those years. Still, this gave us two years of baseline data.

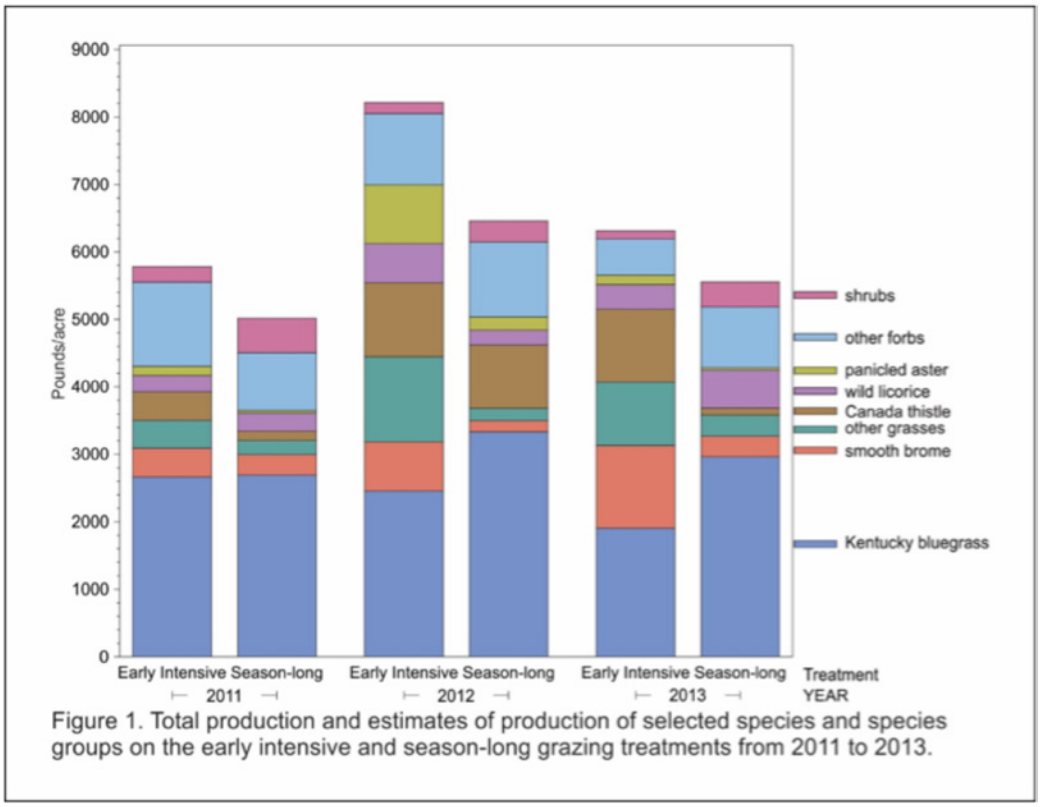

Figure 1. Total production and estimates of production of selected species and species groups on the early intensive and season-long grazing treatments from 2011 to 2013.

Forage production and utilization were determined using the cage comparison method, clipping three times per season. While clipping plots at peak production, an estimate was made of species percentage by weight. All samples were oven-dried and weighed.

Forage production was not significantly different ($P>0.05$) between the early intensive and the season-long grazing treatments. At the time the cattle were taken off the early intensive treatment, they had utilized 42 to 59 percent of the forage produced so far in the season, but only 20 to 33 percent of the forage produced during the entire growing season.

At the time the cattle were taken off the season-long treatment, they had utilized 45 to 63 percent of the forage produced. The differences in total utilization were significantly different between the two treatments each year ($P\leq0.05$).

Production of Kentucky bluegrass was not significantly different in any year, but the three-year average was greater on the season-long treatment than on the early intensive treatment (See Figure 1).

Shrub production declined between 2011 and 2012 and was significantly less on the early intensive treatment than on the season-long treatment in 2012 and 2013.

Species showing significant changes were:

Prairie rose *(Rosa arkansana)* production was greater on the season-long than on the early intensive treatment in 2012.

Buckbrush *(Symphoricarpos occidentalis)* production was greater on the season-long treatment than on early intensive treatment in 2013.

Green needlegrass *(Nassella viridula)* was not found on the early intensive treatment in 2013, but 12 pounds/acre were produced on the season-long treatment.

Western ragweed *(Ambrosia psilostachya)* production was not different between treatments originally, but decreased on the early intensive treatment and became more abundant on the season-long treatment.
Note: Although differences appear to occur in

production of some of the other dominant species in Figure 1, they were not significantly different between treatments.

The early intensive study began in 2011. Only a few species have shown changes in response to the different grazing treatments so far.

Kentucky bluegrass foliar cover and frequency of occurrence declined on the early intensive treatment and increased on the season-long treatment.

The frequency of occurrence of western ragweed decreased on early intensive from 2012 to 2013 and increased on season-long from 2010 to 2013.

Cudweed sagewort *(Artemisia ludoviciana)* frequency of occurrence decreased on early intensive from 2011 to 2013. On the season-long, however, it decreased from 2011 to 2012, and then increased from 2012 to 2013.

Buckbrush frequency of occurrence decreased on the early intensive treatment from 2010 to 2012.

Panicled aster *(Symphyotrichum lanceolatum)* frequency of occurrence increased from 2009 to 2012 on the early intensive treatment.

Smooth brome *(Bromus inermis)* foliar cover increased on the early intensive treatment from 2011 to 2013.

Flodman's thistle *(Cirsium flodmanii)* increased from 2009 to 2012 then decreased in 2013 on early intensive while remaining unchanged on the season-long treatment.

Litter decreased on the season-long treatment from 2009 to 2013. On the early intensive pastures, in contrast, litter decreased from 2009 to 2010, and then increased from 2010 to 2012.

- Kentucky bluegrass begins growth early, and early grazing appears to reduce its abundance in the community.
- Shrub production (buckbrush) is also reduced by early grazing.
- Other species have had mixed responses.
- It may be too early to draw conclusions. This study is continuing with modifications.

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

GRASSLAND RESTORATION PRIORITIZATION: CENTRAL ARIZONA GRASSLANDS DECISION SUPPORT TOOL DEVELOPMENT

Julie Mikolajczyk, Arizona Game and Fish Department

The Arizona Game and Fish Department (AGFD), Bureau of Land Management, US Forest Service, and Natural Resources Conservation Service, are currently implementing the Central Arizona Grasslands Conservation Strategy (CAGCS). The grasslands in central Arizona have become increasingly encroached by pinyon-juniper trees and other shrubs. To support the work of the CAGCS Implementation Team (a multi-disciplinary team that provides the oversight for on the ground projects, budgets, prioritization and public outreach), AGFD is developing a spatial decision support tool to assist in determining the best locations for vegetation treatments in order to improve grassland function and increase permeability for grassland-dependent species such as the American pronghorn.

To support the decision making process, stakeholders from the Implementation Team has outlined a hierarchical series a management questions, which have been collectively grouped into tiers.

• *Tier 1 - To what degree does this area have the potential to be grassland?* This tier considers factors such as soil, slope, and elevation, which are important in determining the geographic extent of grassland vegetation.

• *Tier 2 - To what degree is this area suitable for grassland?* Factors being evaluated for this tier focus on the current status of the landscape and include datasets representing development and protected status, wildlife occupancy, connectivity/landscape integrity, and landscape fragmentation.

• *Tier 3 – To what degree is this area feasible for grassland restoration?* This tier will consider factors such as current and projected land use/land zoning, distance to roads, etc.

• *Tier 4 – What treatment type is most appropriate in this area?* This evaluation will be performed at the project level to help decide which treatment type is most appropriate based on site-specific factors such as tree density, slope, etc.

To answer each of these questions, a GIS analysis is run with a lattice of 54 km2 hexagons (n ≈ 200,000) covering the geographic extent of the CAGCS boundary. A series of GIS analyses populates each hexagon with attributes summarizing variables relevant to answering the management question and assembles this information together using fuzzy logic operators. Since this vector dataset has many attributes as a result of this method, it provides a robust, flexible, and transparent spatial component that can be used to support the process by which decisions are made on where to most effectively remove encroachment in order to improve grassland function. Such transparency is often missing with traditional site suitability analyses performed using raster-based methodology.

For each tier, stakeholders determine how best to rescale the data from 0 to 1 (with 0 representing characteristics that are not at all suitable for the management question being posed and 1 being the most suitable). For example, when considering elevation, the most suitable elevations for grassland vegetation occur between 3000 and 6500 feet. Below

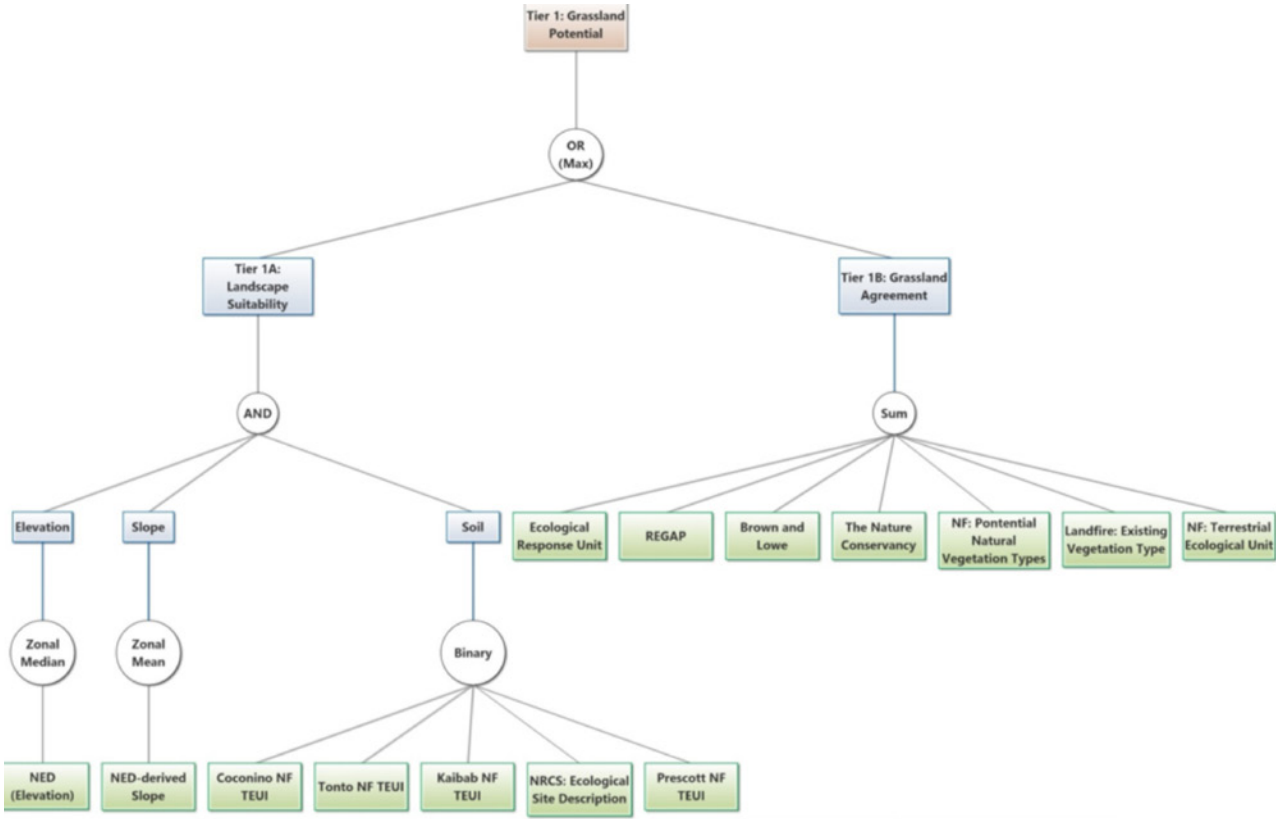

Figure 1: This logic model depicts the various components used when answering the question: To what degree does this area have the potential to be grassland?

3000 feet, the landscape is gradually less suitable for grassland growth. And when you exceed 6500 feet, the landscape is also gradually less suitable. All scores were then linearly rescaled from 0 to 1. This process is repeated for all of the factors identified for each tier's management question. These scores could then be combined using fuzzy logic operators such as AND, OR, UNION, etc. More information on the fuzzy logic operators and details on the methodology is available through the Ecosystem Management Decision Support resources, on which this analysis was based. The decision tree shown in Figure 1 has been created to visually depict the various datasets and combinatorial formulae used for Tier 1 (Grassland Potential). The logic model began with several additional factors not presented here, including impacts to grasslands from grazing, climate change, and invasive species. However, as the analysis process moved forward, the final model was simplified when it was determined that the effects of these factors would more appropriately fall into Tier 3 (feasibility) or site-specific management decisions. At any point throughout the modeling process, a ground-truthing component can be added in to ensure that conditions on the ground are matching with model outputs.

Each factor has been mapped individually and each combined tier has been mapped as well (figure 2 & 3). Since this proceeding cannot include all of the maps, you may go here for more information on the interim and final outputs: **http://www.azgfd.gov/w_c/grasslandsFiles/CAGCSDecisionTool_FinalProgressReport.pdf.** As Tiers 3 and 4 are developed, a final report will be made available on this web page **http://www.azgfd.gov/w_c/grasslandsConserv.shtml.**

Although still in development, the transparent methodology used in this decision support tool are very useful in supporting the prioritization of projects on the ground. Additional factors can easily be overlaid or integrated into the analysis output for a flexible approach. During calendar year 2016, this tool will also be made available through an online viewer and additional resources may be allocated to enhance the viewing capability into an integrated decision support tool where factors can be modified on the fly for new outputs.

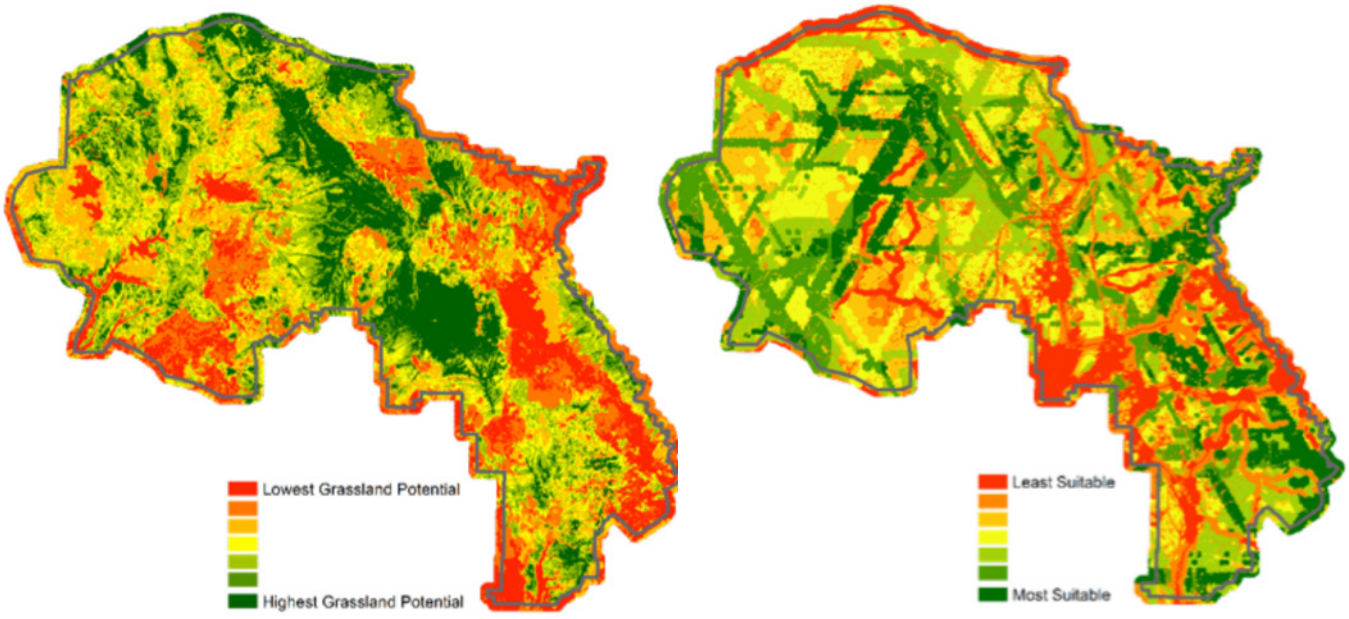

Figure 2: Map on left showing Tier 1 grassland potential. Map on right shows Tier 2 grassland suitability. Data in both maps are displayed using a quantile classification scheme with 7 bins.

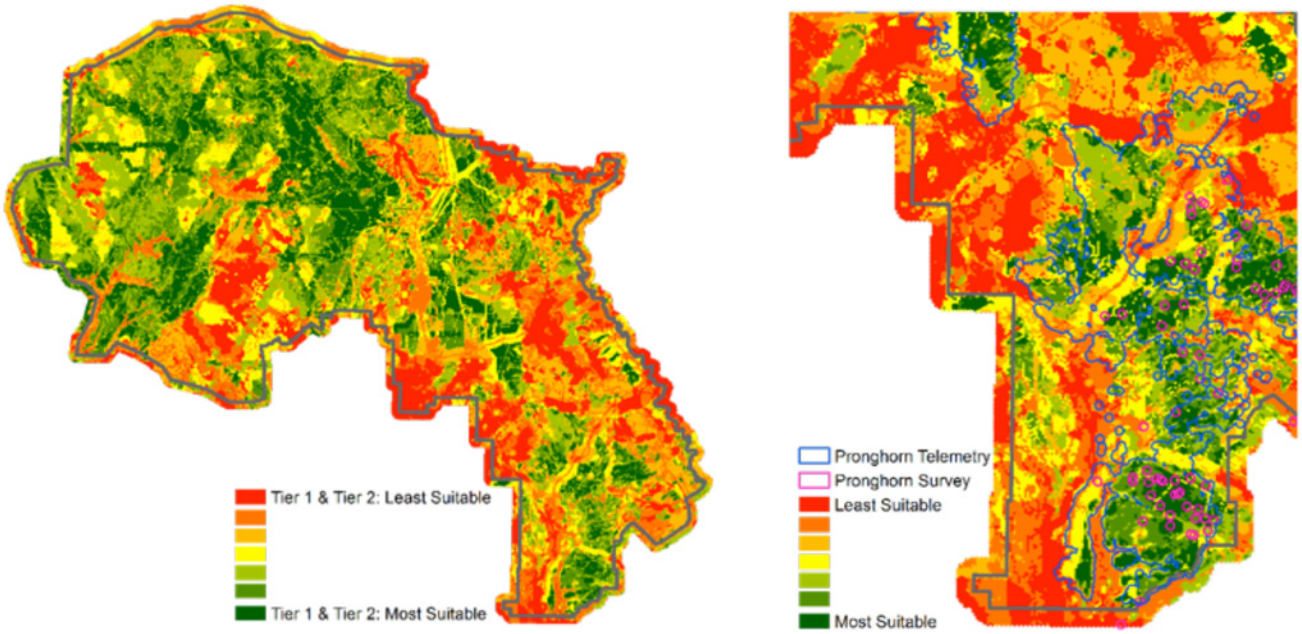

Figure 3: Map on left shows Tier 1 grassland potential and Tier 2 grassland. Data are shown using a quantile classification scheme with 7 bins using a Fuzzy AND combinatorial formula. A change in one or more of the component factors (including the introduction of a weighting system) could result in a change in the final output of these datasets. Map on right shows the same output dataset with pronghorn telemetry and survey data drawn on top. Note that this wildlife data is not available across the entire area, so it should only be used to visualize how well the model identifies potential grassland areas where pronghorn have been observed.

5. GRASSLANDS ALLIANCE SYMPOSIUM

WORKING TOGETHER TO INCENTIVIZE SUSTAINABLE RANCHING

- **Jonathan Gelbard, NRDC**
- **Gabriel Krenza, NRDC and Green Sports Alliance**
- **Michael Hale, Magpie Ranch**
- **Chris Wille, Rainforest Alliance**

Description: Building partnerships along the beef supply chain to better enable, monitor and reward triple bottom line benefits of grassland conservation on working ranches

Part I: Defining, verifying and incentivizing/rewarding sustainable beef production through a certification standard

Part II: An open (and potentially rambunctious) forum to discuss how to fuse the best science and ranching traditions to define sustainable beef production; find common ground among ranchers, conservationists, retailers and consumers; and harness market forces to advance grassland conservation.

Certification standards have been an effective mechanism for building conservation partnerships in other commodities; can that success be replicated in the U.S. beef sector to better incentivize grassland conservation?

Presentation

Suddenly, everyone wants to know how to define "sustainably produced" beef. Ranchers, retailers, burger chains, and others in the sector have seen beef consumption decline as public awareness of the environmental and health impacts of poor management have increased, leaving them worried about their industry's future. Concerned consumer and business buyers want guidance on how to choose beef that they can trust to be more "sustainable". Conservationists are looking for ways to incentivize more ranchers to become allies in our shared quest to be good stewards of grasslands – to keep working lands working while protecting native wildlife and conserving open space.

Value chain participants – from producers to consumers – have rallied around certification standards to incentivize conservation in other sectors. The latest trend is to develop outcome-based (rather than practice-based) standards that, together with producer training and support programs:

- define scientifically recommended outcomes, (such as "high conservation value areas are protected from land conversion and degradation"),

- develop guidance manuals that offer producers options of locally appropriate best management practices (BMPs) for achieving required outcomes;

- provide a system of assessments, monitoring and evaluation that transparently identifies problems and monitors progress improving management;

- offer positive incentives to participating producers – such as technical assistance, financing, and access to premium markets;

- hold everyone in the value chain – from producers to retailers to consumers – accountable, and

- build a solid, multi-stakeholder platform for communication and collaboration.

Standards have been the catalyst for generating conservation results in other sectors – forest products, fisheries, coffee, tea, cocoa, and palm oil. It's past time for the U.S. beef sector to agree on principles, criteria, and indicators of sustainability by establishing a comprehensive certification standard.

The U.S. Roundtable on Sustainable Beef has taken important first steps, convening major retailers and restaurant chains, big meatpackers, and a small number of NGOs to agree to set and test performance indicators, using the Global Roundtable on Sustainable Beef's Principles and Criteria. The Grasslands Alliance, an NGO-managed coalition of conservation groups, is building on that work by developing an independent, science-based and practical certification standard that enables business and consumer buyers to recognize beef produced on certified well-managed ranches and farms. Grasslands Alliance was established by Rainforest Alliance, Food Alliance, and NRDC, and has support from the Sustainable Agriculture Network (SAN), the NGO coalition in the tropics that owns and manages the standard that underwrites Rainforest Alliance Certified©.

Grasslands Alliance, using the Food Alliance and SAN standards as models, gathered input from scientists, ranchers, conservationists and others to draft a standard that will soon be released for public comment. Other NGOs are joining the Alliance as we form a broad and growing coalition to establish the gold standard for recognizing beef produced on ranches that generate positive environmental, public health, animal welfare, and social outcomes.

Grasslands Alliance is also developing support programs to enable ranchers to gain access to the technical assistance, financial services, and other resources they need to improve management and access the benefits of certification. We will connect certified producers with premium markets, verify their marketing claims (thus building trust in certified brands), raise awareness among consumers about the accomplishments of our supply chain partners, and bring market forces to bear on policy as well as land-management practices. Collaborating with

academic, NGO, ranching, and other partners, the Alliance is developing a monitoring, evaluation and research program to establish baselines and measure the ecological, economic and social impacts of our programs.

This breakout group will be a moderated panel discussion that addresses frequently asked questions about certification and concludes with a listening session that invites stakeholders to share their ideas on how partnerships with the beef supply chain can better incentivize grassland conservation. This unusual, eye- and mind-opening session will blend the ecological and social sciences, revealing the connections between grassland conservation, grazing and ranch management, environmental or "green" marketing claims, natural resource economics, public policy, market dynamics, and the rapidly shifting demands of the millennials, the largest consumer block.

Questions posed by the moderator in the following two topics may include:

1. Part I: Why a certification standard?

a. Is a standard the best way to define "sustainability" in the U.S. beef sector?

b. Aren't there already standards for beef in the U.S., like Organic, Grass-fed, and Natural? Why does the marketplace need another?

c. Is there scientific evidence that standards and certification have helped change land-use practices and generate real conservation results in other sectors? If so, can we expect them to be equally effective in the U.S. beef sector?

d. How does certification enable marketing claims such as "Sustainable Beef!" to be verified and made more credible?

e. Even if a standard is effective in improving grassland stewardship, how will it also benefit producers, retailers, restaurant chains, and consumers? Are incentives for producers really enough to generate a positive return on investment in management changes and to overcome economic and social barriers to change?

f. What is the potential scope of the Grasslands Alliance standard? Which grassland conservation issues can be addressed?

g. Can the Grasslands Alliance standard and certification program be a useful policy tool for advancing grassland conservation?

2. Part II: How will the Grasslands Alliance foster collaboration and partnerships for advancing grasslands conservation?

a. Between ranchers/farmers and NGOs? The program provides a framework for collaboration that unites disparate stakeholders around the shared conservation goals and desired outcomes defined in the standard. Working together, collaborators can tackle deeply technical ranch management challenges, local and national policy issues such as the Farm Bill, producer needs such as technical and financial assistance, and changing consumer demands.

b. Among ranchers and farmers themselves? These partnerships expand producer networks, fostering exchanges of knowledge, experience, and innovative conservation practices among cooperatives of like-minded ranchers. Producers in the program will have a common bond and influence that they can wield to influence markets and policymakers.

c. Between producers and buyers? Another way the program will incentivize conservation is by connecting producers with opportunities to sell certified beef to new buyers and markets – from stadiums to local steak restaurants. Well-managed ranches are also more resilient to drought and other unexpected events, decreasing year-over-year supply chain risks for buyers and producers alike.

d. All along the value chain, from producers, to meatpackers and processors, to retailers, brands and consumers? Certification not only builds consumer trust

in sustainability-related beef marketing claims and protects brands from costly accusations of "greenwash" (making false or unsubstantiated claims). It is also a valuable tool for the increasing numbers of processors, retailers, and restaurant chains who are seeking credible means to achieve beef supply chain sustainability goals that reflect real conservation results.

The panelists answered these questions and more as we explored how standards and certification can foster partnerships with the U.S. beef supply chain to better incentivize grassland conservation.

6. GRASSLAND DEPENDENT WILDLIFE

MOVEMENT PATTERNS OF GRASSLAND SPARROWS WINTERING IN THE CHIHUAHUAN DESERT

Erin H. Strasser, Bird Conservancy of the Rockies

Other Authors: Arvind O. Panjabi and Viviana Ruiz-Gutierrez, Bird Conservancy of the Rockies

Grassland birds are declining at a faster and steeper rate than any other guild of North American birds yet there is little information on their winter movements and habitat preferences. Gathering information on animals and their space us is one of the first steps for understanding mechanisms that underlie species densities or occurrence, habitat selection, responses to land-use change, climate change, and indices of fitness such as survival and nest success, and can have population level implications. We used radio-telemetry to characterize home ranges, movement patterns, and habitat selection for two declining grassland birds, Baird's and Grasshopper Sparrows on the wintering grounds in Northern Chihuahua, Mexico. Both species breed in the Great Plains of North America, have declined by more than 70% since the 1960's, and winter in the limited and threatened Chihuahuan Desert grasslands.

Sparrows were radio-tagged and tracked between December and mid-March of winters 2012-13, 2013-14, and 2014-15 at the Reserva Ecológica "El Uno" near Janos, Chihuahua. Birds were located once to twice daily, and locations were recorded with a GPS. We used kernel density estimators of the utilization distribution (adehabitatHR, Program R) to estimate home range size and overlap for each species (Baird's n=50, Grasshopper n=96). We also examined strategies of space use which could vary between individuals or winters based on endogenous (sex, age, behavioral phenotype) or exogenous factors (e.g. climate, predation pressure, habitat conditions). Birds were categorized as "sedentary" or "floaters" based on their movement patterns. Sedentary individuals used a contiguous area and did not make a long distance shift (greater than 200m) to a new territory. Floaters were those that did not maintain a singular fixed area over the course of the winter.

Sparrow home range size did not vary significantly between winters and averaged 5.09 ha (min= 0.22, max= 48.90 ha, Figure 1). Sparrow space use was highly variable between individuals and winters. For all seasons, most birds (60-75%) were sedentary and used a contiguous area over the winter. Fewer birds were floaters in 2012-13 (30%) than 2013-14 (44%) and 2014-15 (33%) fell in the middle. Floaters were broken into two categories: most made home range shifts from one disjunct location to another (had multiple home ranges) and a few individuals moved over large areas throughout the season. Sex did not influence movement strategy.

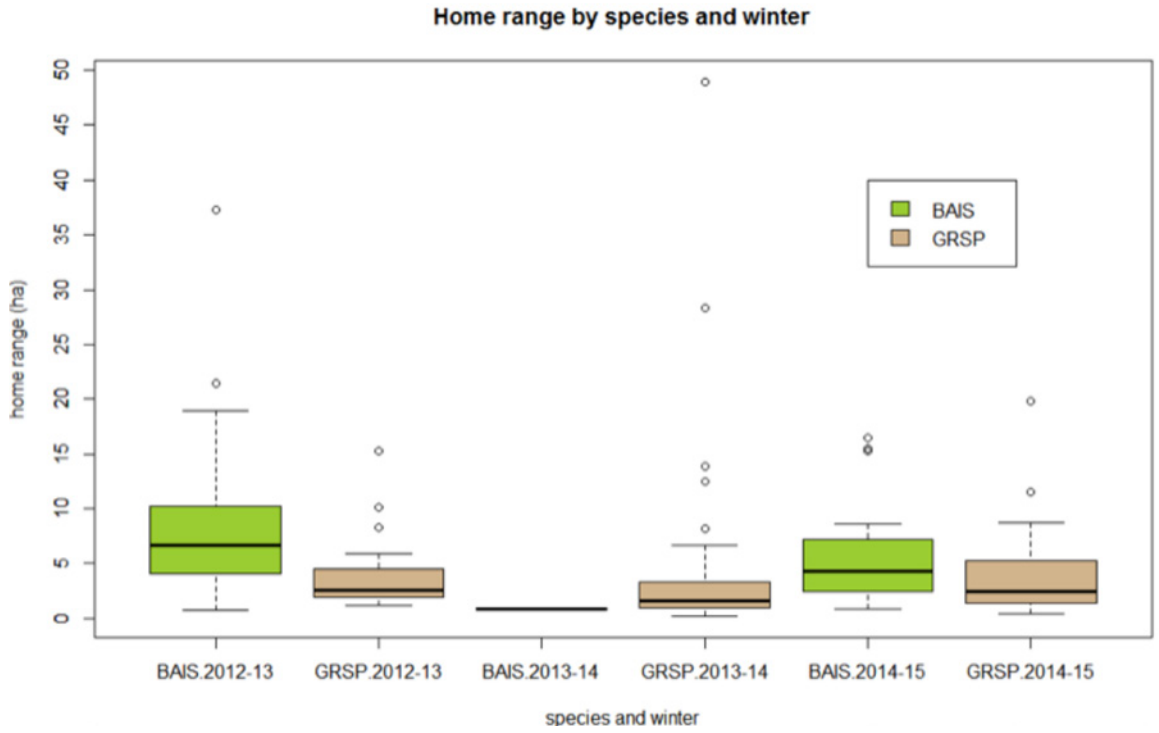

Figure 1: Home range size (in hectares) for wintering Baird's Sparrows (BAIS) and Grasshopper Sparrows (GRSP) by winter (2012-13, 2013-14, and 2014-15).

There are several possibilities for variation in movement patterns and why floaters were more prevalent in 2013-14: Bird densities were higher in 2013-14 which may have reduced predation pressure and thus facilitated movement. Climate conditions and habitat can also play a role in grassland bird movements. Pre-winter precipitation during the growing season affects grass cover and seed production, factors critical to grassland bird survival. During summer 2013, heavy rain created favorable wintering grassland conditions and higher quality habitat overall may have lessened the need to defend a particular territory.

An understanding of relationships among spatial and temporal patterns of space use and habitat attributes are needed to assess how grassland birds will respond to changing habitat and climactic conditions on the wintering grounds. Ultimately this research ties into our goal of understanding causes of grassland bird declines, which may be related to low overwinter survival. We will maintain this research over the course of several more seasons to fully capture and understand variation between years in patterns of space use and the mechanisms driving these patterns as well as explore the possible implications of movement patterns on winter survival. **http://grasslandsalliance.org/**

SUSTAINABLE GRASSLANDS: USING THE LONG-BILLED CURLEW TO FOCUS CONSERVATION EFFORTS ON WORKING LANDS

Cheryl Mandich, American Bird Conservancy

Grassland birds have shown the most widespread and severe population declines of any suite of birds in North America, with some species down 75-90% over the past 50 years. Habitat conversion has played a huge role in these declines, and there is continuing pressure to put native grasslands into production. Energy and

residential development are placing additional stress on these habitats, as larger blocks of habitat are fragmented by roads and infrastructure.

Many of these bird species are adapted to grassland systems where grazing by large herbivores (e.g. bison) and periodic disturbance by fire were common, meaning there are opportunities to manage for these declining species on working farm and ranch lands. Some require shorter-stature grasses for nesting, while others prefer more residual cover. Stemming or reversing population declines may be possible if further habitat conversion can be minimized, in combination with the adoption of appropriate management actions to maintain or enhance the grassland habitat qualities needed by each species (or those with similar needs).

The Long-billed Curlew is used as the focal species to target habitat conservation delivery in the portions of the Northern Great Plains. It is North America's largest shorebird with a population estimated at fewer than 200,000 birds. Curlews breed and nest in grassland landscapes throughout the United States and southwest Canada (Fellows and Jones 2009), and winter primarily in southern California, Mexico and along the Gulf Coast (Figure 1). Roughly 50% of the breeding curlew population is found in the Northern Great Plains.

The species is not listed as threatened or endangered (nor has this been proposed), and its habitat needs can be met in working agricultural landscapes with appropriate management. The bird is recognized as a conservation priority by state and federal wildlife agencies and organizations, in part due to long-term declines. Since it co-occurs with other declining species across its range, sustainable management of working lands for curlews can also provide for the needs of other birds and wildlife. Loud, large, and fiercely territorial, it is easily recognized and therefore easily monitored.

The 2013 report completed by ABC for the Natural Resources Conservation Service (NRCS) Conservation Effects Assessment Program (CEAP), Assessing the Effects of Conservation Practices 2005-2011, concluded that conservation of this charismatic and recognizable species could be achieved in large part through United States Department of Agriculture (USDA) conservation programs, but only if delivery was focused geographically and incorporated specific management actions to address habitat needs.

The 2013 State of the Birds Report (www.stateofthebirds.org) emphasized the importance of private lands to bird and habitat conservation. Grasslands cover 358 million acres of the U.S., provide critical wetland buffers that improve water quality, and often times are managed as working lands that provide food, fiber and other resources. Of these grasslands, 85% are privately owned and provide important habitat for 29 breeding obligate grassland bird species. Management practices that promote healthy grasslands while meeting the economic bottom line for private landowners are key to maintaining grassland bird populations.

ABC is working closely with many partners in portions of North and South Dakota, Montana, and Wyoming to assist landowners in conservation planning and implementing NRCS programs and practices to sustain the economic value of working lands while improving and conserving habitat for declining or at-risk bird species. NRCS practices **(http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg/)** have the potential to meet the needs of breeding curlews, particularly where native mixed grasses and forbs have been planted, or where there is willingness to switch to native vegetation. We assist private landowners in conservation planning and enrollment in NRCS conservation programs where sustainable management practices for grasslands and livestock production will also result in habitat conservation for multiple declining or at-risk bird species, including Long-billed Curlew, Sprague's Pipit, McCown's and Chestnut-collared Longspurs, Lark Bunting, Loggerhead Shrike, and Baird's and Brewer's Sparrows.

Under a 2012 Neotropical Migratory Bird Conservation Act (NMBCA) grant, ABC worked with Canadian and U.S. partners to compile strategies for Long-billed Curlews on their breeding grounds (sagebrush, agricultural and grassland habitats) and identify focal areas for conservation (Figure 1; Casey 2013). We also worked with partners in Mexico to protect and improve management of a key wintering site for 30% of the curlew population.

We suggest implementing the following set of recommended management actions and guidelines wherever practicable within the breeding range of the Long-billed Curlew in North America. They are adapted from Dechant et al (1999) and Cannings (1999) and are meant to also benefit other grassland species associated with native grassland habitats. These guidelines are summarized in ABC's "Land Manager's Guide to Grassland Conservation and the Long-billed Curlew" (**http://www.npcn.net/documents/LBCU_brochure.pdf**. Implementation of these actions will be most effective on landscapes already known to be inhabited by breeding curlews. The timing of breeding, appropriate stocking rates, seed mixes and opportunities will vary regionally, as well as by site.

Manage Grazing Appropriately

- Remove tall, dense residual vegetation before the spring arrival/pre-laying period (graze in fall/winter). Target date: 15 March (adjusted regionally/locally).
- Adjust timing and intensity of grazing to leave grass cover 10-30 cm tall by the time of nest initiation. Target date: 15 April (adjusted regionally/locally).
- Retain 5% of grasses and forbs in taller condition (30-40 cm) for broods.
- Avoid grazing during the incubation and nestling period, to avoid potential for trampling. Target dates: 15 April – 15 July (adjusted regionally/locally)
- Do not drag hayfields to break up cowpies.

Halt Habitat Conversion

- Prevent conversion of grassland or shrub-steppe, particularly in landscapes with wetland elements.
- Maintain or manage for grassland block sizes of >120 acres.
- Manage the forest fringe to minimize/reverse forest encroachment using slashing or other suitable method.

Emphasize Native Grasses and Forbs

- Burn areas only where and when fire intensity will reduce shrub coverage and increase habitat openness without reducing the diversity of native grass and forbs.
- Avoid seeding with non-natives (e.g. crested wheatgrass).
- Use locally-appropriate native bunchgrass/forb seed mixes for restoration and revegetation efforts.
- Where necessary, manage taller non-native grass cover with grazing, mowing or fire to maintain low profile vegetation prior to the nesting season.

Avoid Disturbance during Sensitive Periods

- Protect breeding habitat of curlews from detrimental human activities, such as vehicular use, construction activities, and shooting.
- Do not construct additional roads in occupied curlew habitat unless there is no other practicable option. Limit road use during the breeding season (March 15-July 15).

Adjust Certain Agricultural Practices

- Reduce pesticide use on grasslands, especially near water, to maintain both terrestrial and aquatic invertebrates as a food sources.

- Avoid widespread pesticide applications aimed at controlling grasshoppers.
- Reduce herbicide use to maintain nesting, loafing, and brood-rearing cover.
- Postpone tilling until at least mid-June in those agricultural habitats used for nesting.
- Whenever possible and practicable, favor flood-irrigation of hay meadows over sprinkler systems.

We present these as overall guidance to land managers across the range of the species, but urge local partner cooperation and consultation during their implementation. This will help ensure that local expertise and landowner management objectives are taken into account.

This initiative leverages the substantial expertise of a diverse partnership through the Northern Great Plains Joint Venture **(http://ngpjv.org/)** to assist producers in conservation planning and implementation of NRCS and state conservation programs and practices for sustainable ranching that benefits at-risk grassland birds, soil and rangeland health, and water resources. Multiple benefits to livestock and wildlife will be realized from this initiative, including reduction of grassland loss, drought mitigation, soil health improvement, rangeland health, carbon sequestration, flood prevention, and water retention.

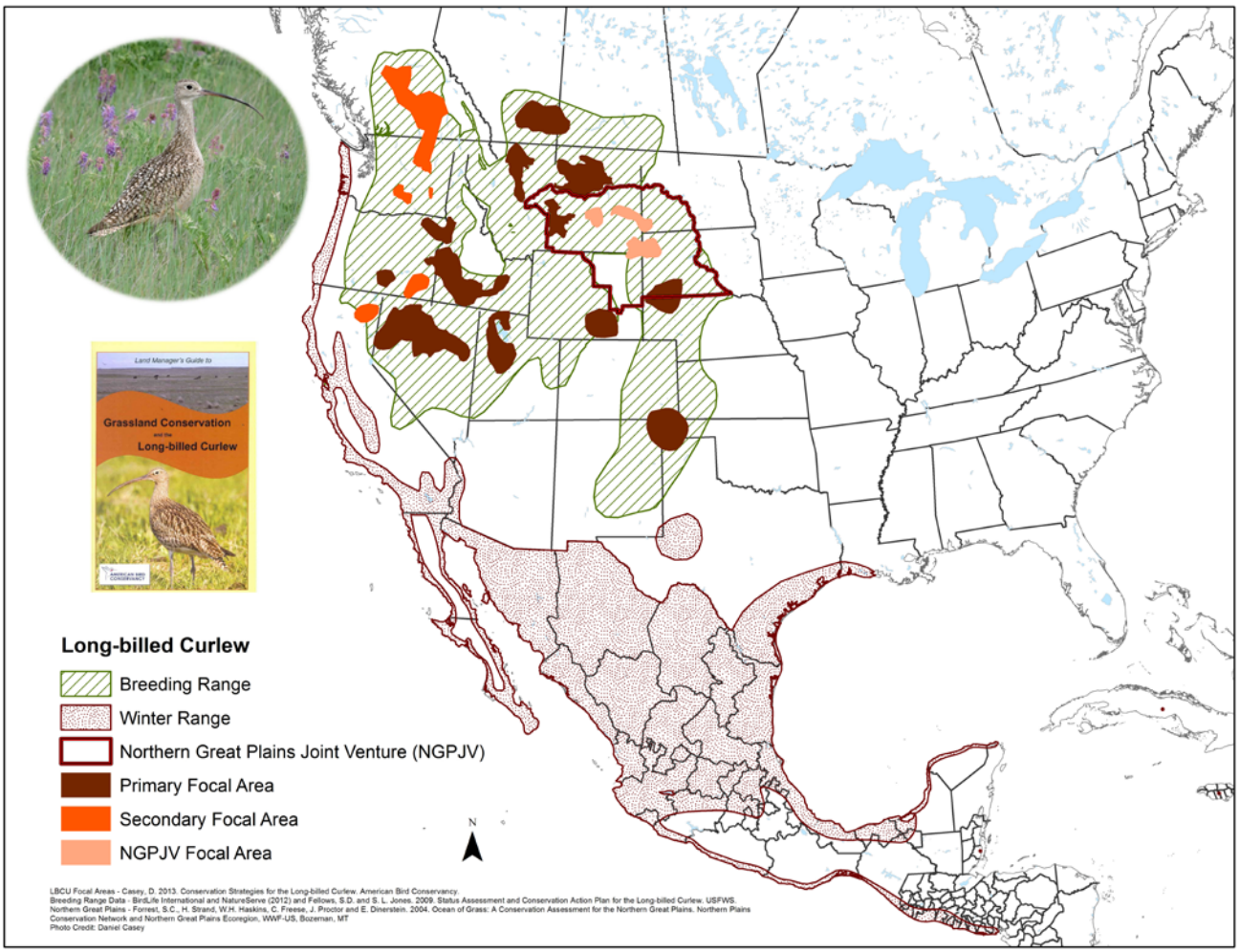

Figure 1. Long-billed Curlew breeding and winter ranges along with breeding range conservation focal areas.

It is also a critical component of an international effort to advance conservation of grassland birds and their habitats on both their wintering and breeding grounds as many of the migratory grassland birds that breed in the Northern Great Plains winter in Mexico. ABC, ProNatura Noreste, Bird Conservancy of the Rockies and other partners are working cooperatively in Mexico with private landowners to protect and improve the quality of these grasslands for grassland birds while maintaining economic viability. We are working with our partner Pronatura Noreste, to improve grassland conditions through sustainable grazing practices and enhancing vital wetlands that provide key wintering concentration sites for Long-billed Curlews. We're also coordinating closely with Bird Conservancy of the Rockies to incorporate demographics information into conservation strategies and to monitor bird response to grassland restoration.

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MIGRATORY GRASSLAND BIRDS OF THE GREAT PLAINS: A COMPARISON OF MIGRATIONS OF FIVE SPECIES AND THE IMPLICATIONS FOR CONSERVATION

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Grassland birds are highly imperiled and their populations have declined steeply (populations of 24 species have declined by an estimated >40%) since the 1960s. These declines are attributed to the loss of grassland habitat, largely associated with conversion for agricultural crops. For migratory grassland birds, the identification and characterization of migratory pathways is essential for 1.) determining the relative importance of grasslands in their annual cycle, 2) assessing the relative impacts of population-level connectivity (ranging from high to low and widely dispersed) and 3) measuring the demographic impacts of conditions and events (e.g., drought, habitat loss, etc.) To address this need, we have assembled for comparison recent tracking data for five species of migrant grassland birds with an array of life histories: the Ferruginous Hawk (*Buteo regalis*, N=24), Long-billed Curlew (*Numenius americanus,* N=14), tracked with satellite transmitters; Mountain Plover (*Charadrius montanus*, N=4), and Chestnut-collared Longspur (*Calcarius ornatus*, N=7) tracked with archival light-level geolocators; and Burrowing Owl (*Athene cunicularia*) tracked with both transmitters (N=12) and geolocators (N=23).

By comparing aspects of how (complete migration versus one with many stop-overs), when (timing by date, but also nocturnal versus diurnal), and where these species migrate (migratory pathways and endpoints), we will begin to gain insight into the roles that grasslands play in the annual cycles of these species. We will also identify any overlaps in time and space that can be used to better guide efforts aimed at conserving these species (types and/or timing of habitat management, targeted protection through easements or other programs, etc.). Such basic information is needed to begin to develop demographic models as well as scenario planning for potential conditions under a changing climate.

BIRD COMMUNITY RESPONSE TO PLAGUE MANAGEMENT IN PRAIRIE DOG COLONIES

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Range-wide declines in prairie dog (*Cynomys* spp.) populations have occurred, and the largest limiting factor in recent decades appears to be the high mortality and colony extirpation associated with non-native plague (Antolin et al. 2002), caused by the bacterium *Yersinia pestis.* Prairie dog colonies support a diverse community of associated species (Lomolino and Smith 2004; Smith and Lomolino 2004), many of which are not susceptible to plague but may be indirectly affected. For example, mountain plover *(Charadrius montanus)* occupancy rates (Dinsmore and Smith 2010) and nest numbers (Augustine et al. 2008) decline following plague outbreaks. Burrowing owls *(Athene cunicularia)* nest at high densities in areas with extensive burrow systems that are recolonized by prairie dogs after a plague outbreak, but they abandon extirpated colonies within a few years (Conrey 2010).

In order to conserve prairie dogs and species associated with their colonies, principally the black-footed ferret *(Mustela nigripes),* a plague vaccination program is being developed. Colorado Parks and Wildlife (CPW) is involved in a multi-state, multi-agency study of prairie dogs and associated small mammal species; the objective is to determine whether survival is enhanced by the experimental vaccine compared to use of placebo or insecticide to control fleas, an important vector of plague. As an extension to this project, we initiated research in 2013 on the effects of plague management on avian species associated with prairie dog colonies, with particular focus on species of concern. Our main long-term objective is to determine whether areas treated to control plague differ from untreated areas in their avian communities. Shorter-term objectives are to 1) Determine how plague affects avian species and their predators associated with prairie dog colonies; 2) Determine whether insecticidal dusting influences bird density or nest survival; 3) Evaluate the importance of covariates such as weather and cattle grazing.

Study areas included black-tailed prairie dog (*C. ludovicianus:* BTPD) colonies in north-central Colorado and Gunnison's prairie dog (*C. gunnisoni:* GUPD) colonies in west-central Colorado. BTPD study colonies were dominated by short and mid-grasses, while GUPD study colonies were dominated by sagebrush mixed with other shrubs and grasses. We completed three years of avian data collection, which coincided with the CPW Wildlife Health Program's 3-year efficacy trials for the plague vaccine. CPW staff surveyed colonies before and after bait distribution and conducted a mark-recapture study of prairie dogs and associated small mammal species. Treated areas were arranged in triplets with one vaccine, placebo, and dusted site per group; baited sites were assigned vaccine or placebo baits in a blind procedure. For collection of avian data, we created a 250 m point grid to sample all treated and untreated prairie dog colonies on public land within the study region. Data analyses are ongoing. Bird occupancy, density, and species composition will be estimated from point count data. Summer and winter counts of diurnal raptors and early season call-playback surveys of mountain plover and burrowing owls were used to sample species that are rarely detected during

Photo Credit: Miranda Middleton, Estimating age of lark bunting eggs on a black-tailed prairie dog colony.

point counts. Nest survival rates will be estimated for passerines and burrowing owls. Remote camera data will be used to estimate summer and winter occupancy rates for mammalian carnivores, including coyote *(Canis latrans),* swift fox *(Vulpes velox),* and badger *(Taxidea taxus).* Finally, we have quantified percent ground cover, visual obstruction, and species composition of vegetation at points, nests, and along randomly located transects.

Since fall 2013, plague epizootics have occurred on one GUPD colony and across ~70% of the BTPD study area. In September and October 2014 and 2015, black-footed ferrets were released in three BTPD study colonies. Precipitation has varied greatly over the three years of this study, particularly on BTPD sites, from slightly dry to very wet, compared to the 30-year average. Preliminary inspection of BTPD colony survey data suggest at least three bird species (Brewer's blackbird *Euphagus cyanocephalus,* Brewer's sparrow *Spizella breweri,* and vesper sparrow *Pooecetes gramineus*) had higher detection rates on active prairie dog colonies, while two species (grasshopper sparrow *Ammodramus savannarum* and lark bunting *Calamospiza melanocorys*) had higher detection rates on colonies with extinct or severely reduced prairie dog populations following plague outbreaks. Vegetation species composition was highly variable at BTPD sites over time, with increasing grasses and forbs and decreasing bare ground during plague outbreaks and an El Niño event associated with high rainfall during the growing season. Apparent nest success varied between 50 and 57%, except that it was 40% on BTPD colonies and 69% at GUPD colonies in 2014. The decrease at BTPD colonies was likely attributable to hail storms and flooding during the peak nesting season in 2014, but prior to doing a thorough nest survival analysis, there was no obvious explanation for increased survival at GUPD colonies that year. In > 1 million remote camera photos, we have documented decreased coyote activity and increased swift fox activity as rainfall and plague activity increased.

Additional years of monitoring are needed to detect potential changes in the avian community caused by different types of plague management, as treated colonies no longer experience extinction events. Regardless of the efficacy of plague vaccine versus

Photo Credit: Miranda Middleton, Horned lark nest on a black-tailed prairie dog colony.

Photo Credit: Sean Streich, Gunnison's prairie dog consuming a vaccine bait.

insecticide in reducing plague impacts, the vaccine will continue to be an important tool due to cost/benefit of its use and increasing evidence that fleas are evolving resistance to deltamethrin. Preliminary data suggest that bird densities vary according to the status of prairie dogs on a colony, with differences between active colonies and those with extirpated or severely reduced prairie dog populations following plague outbreaks. We anticipate that phase 2 of this project will have a larger spatial scale, with the plague vaccine used more broadly as a management tool, but finer focus, depending on results of our avian data analyses.

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RANGEWIDE ASSESSMENT OF PRIORITY AREAS FOR THE CONSERVATION OF PRAIRIE DOG ECOSYSTEMS: INTEGRATING HABITAT SUITABILITY, LAND USE PATTERNS, AND CLIMATE CHANGE

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We propose to evaluate landscapes across the geographic ranges of the five species of prairie dogs, from Canada to Mexico – spanning the Plains and Prairie Potholes, Great Plains, Desert, Great Basin, Great Northern, and Southern Rockies Landscape Conservation Cooperatives (LCC) regions. Our analysis will incorporate biotic and abiotic determinants of habitat suitability at local scales with landscape-scale patterns of land use change and climate change in order to quantitatively compare suitability of landscapes for long-term conservation of prairie dog ecosystems.

Prairie dogs (*Cynomys* spp.) are keystone species in North American grasslands, and declines in their populations can induce cascading losses in associated species and grassland habitat. To identify priority areas for long-term prairie dog ecosystem conservation, we propose to first develop state-of-the-art habitat suitability models (HSMs) for all five species of prairie dogs, using ensemble forecasting and extensive spatial data that our team recently collected for all known prairie dog colonies and high resolution data on land cover, climate, elevation, slope, and soils. We then propose to compare priority areas based on land use and land ownership patterns as well as the presence of associated and threatened species, colony size, connectivity, and conservation potential, and use this together with expert opinion to map key areas to protect. We will identify the best areas to protect for both today's climate and for the future, under climate change. Priority area model selection will be informed and reviewed by land managers and other regional experts, and model validation will be assessed with field data collected by experts. Resulting models and map products will inform managers on the key areas of conservation importance for prairie dogs and associated species across North America's central and western grasslands.

These models will provide land managers throughout the LCC region's covered with a valuable decision support tool for conservation and management. Finally, we will engage in community outreach to communicate our results, and work collaboratively with land managers and Non-Governmental Organizations (NGOs) to implement on-the-ground priority area conservation.

GRASSLANDS CONSERVATION BY MANAGING PLAGUE: A VACCINE FOR THE FUTURE?

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The Black-footed Ferret Recovery Implementation Team (BFFRIT) Executive Committee is conducting a project to test, and (if proven effective) eventually implement, an experimental sylvatic plague vaccine (SPV) program for prairie dogs (*Cynomys* spp.). The project is a component of the Western Association of Fish and Wildlife Agencies (WAFWA) Grasslands Conservation Initiative. It involves 25 collaborating

state, federal and tribal agencies and nongovernmental organizations in testing the vaccine at 29 sites on public and tribal lands in seven western states (i.e. each site has a pair of control and experimental plots). SPV could be the biggest breakthrough in recovery efforts for the federally listed black-footed ferret *(Mustela nigripes)* since the 1981 rediscovery of wild ferrets near Meeteetse, Wyoming. Research scientists at the U.S. Geological Service National Wildlife Health Center and the University of Wisconsin (Madison) developed the vaccine and are central to field-testing and data analyses. If proven efficacious, the vaccine could enable agencies and cooperators to combine its use with currently available pesticides to maintain specific populations of prairie dogs at robust levels. This would enable land and wildlife management agencies to enhance rangewide conservation of those species and the grasslands to which they are essential, as well to speed recovery of the ferret, while enabling control of other prairie dog populations to resolve site-specific agricultural and human health concerns. The results of clinical and field-testing in the early stages of developing and testing this vaccine are preliminary but encouraging. The third and final year of field-testing is underway now. Baiting will end this year but all field sites will collect a final season of biological samples in 2016. A final report on the project will be available in 2017. A strategic plan for broad-scale application is also being developed for possible use when testing has been completed and (if warranted) the vaccine is licensed and registered for governmental use. This presentation will cover all aspects of the project.

Photo credit: Aviva Glaser.

ARIZONA ANTELOPE FOUNDATION SOUTHEASTERN ARIZONA GRASSLANDS PRONGHORN INITIATIVE

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Other Authors: John Millican, Caroline Patrick, Shane Stewart, Tice Supplee, Arizona Antelope Foundation

In 2011, 2013 and 2014 the Arizona Antelope Foundation was awarded 3 different National Fish and Wildlife Foundation grants totaling $510,000 to support the AAF's 5-year Southeastern Arizona Grasslands Pronghorn Initiative initiated in April 2010. Matching non-federal contributions valued at $510,000 include: AAF and private land owner project labor and materials; Pima County Sonoran Conservation Plan land acquisition funds and Arizona Game and Fish Big Game Tag Habitat Partnership Funds. The "Southeast Arizona Collaborative Grassland Workgroup", created in February 2010, collaboratively drafted a southeastern Arizona Regional Pronghorn Strategy to: Increase Pronghorn population numbers, distribution and connectiveness. Partners in this working group include: AAF, AGFD, BLM, USFS, SLD, USDA, USFWS, Pima County, Arizona Wildlife Federation, Nature Conservancy, Audubon Society, Tombstone High school and local ranchers/landowners. Long-term goals for this 6-year grant period 2011-17 are to:

1) establish a region-wide dynamic geodatabase with integrated multi-species layers to prioritize grasslands restoration/maintenance activities for pronghorn and other sensitive grassland species,

2) permanently record pronghorn travel corridors and remove or modify barriers, including fences, shrubs and trees, 3) target/plan grassland treatments/ burns in priority habitat locations on an annual and long-term basis to benefit the highest number of keystone grassland species, 4) supplement at least one pronghorn population and increase numbers in two

subpopulations and 5) improve grassland habitat in five pronghorn subpopulation zones. We discussed our progress to date and outline the multiple relationships that are ensuring that the initiative succeeds for the long-term benefit of southeastern Arizona's Pronghorn herds.

VULNERABILITY OF SHORTGRASS PRAIRIE BIRD ASSEMBLAGES TO CLIMATE CHANGE

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The habitats and resources needed to support grassland birds endemic to North American prairie ecosystems are seriously threatened by impending climate change. To assess the vulnerability of grassland birds to climate change, we consider various components of vulnerability, including sensitivity, exposure, and adaptive capacity (Glick et al. 2011). Sensitivity encompasses the innate characteristics of a species and, in this context, is related to a species' tolerance to changes in weather patterns. Ground-nesting birds, including prairie birds, are particularly responsive to heat waves combined with drought conditions, as revealed by abundance and distribution patterns (Albright et al. 2010). To further assess sensitivity, we estimated reproductive parameters of nearly 3000 breeding attempts of a suite of prairie birds relative to prevailing weather. Fluctuations in weather conditions in eastern Colorado, 1997-2014, influenced breeding performance of a suite of avian species endemic to the shortgrass prairie, many of which have experienced recent population declines. High summer temperatures and intense rain events corresponded with lower nest survival for most species. Although dry conditions favored nest survival of Burrowing Owls and Mountain Plovers (Conrey 2010, Dreitz et al. 2012), drought resulted in smaller clutch sizes and lower nest survival for passerines (Skagen and Yackel Adams 2012, Conrey et al. in review). Declining summer precipitation may reduce the likelihood that some passerine species can maintain stable breeding populations in this region of the shortgrass prairie.

Climate projections for the Great Plains prairie region predict a future of hotter and drier summers with strong multiyear droughts and more frequent and severe precipitation events (Cook et al. 2015). Increasing exposure to drier conditions and more summer days of maximum temperatures exceeding 35oC, the documented tolerance for nest survival, is highly likely.

Throughout their evolutionary past, birds of semiarid grasslands have experienced highly variable climates, including extensive droughts. Prairie bird populations have persisted through millennia of both climate stasis and extreme variability, most likely coping with changes by broadening niches or redistributing on the landscape.

Adaptive capacity, the ability to withstand modern day perturbations such as climate change, depends on species life-history traits such as dispersal abilities, genetic diversity, and behavioral and physiological plasticity (Nicotra et al. 2015). The amount of genetic variation within populations may reflect exposure to past climatic events (Nicotra et al. 2015) and thus may be sufficient to allow for some degree of adaptation. Whether there is sufficient adaptive capacity among grassland birds to contend with the rapid rate of modern climate warming, land use change, and human perturbations of grassland systems is unknown and is the focus of ongoing efforts of research colleagues in the U.S. Geological Survey, U.S. Department of Agriculture Agricultural Research Service, Colorado State University, and the Bird Conservancy of the Rockies.

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Photo credit: Aviva Glaser.

CONSIDERING BIRDS AND ECOSYSTEM SERVICES TO INFORM GRASSLAND BIRD CONSERVATION IN AN URBAN CONTEXT

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As the result of urban development and vast agricultural expansion, the United States has lost 98% of its original tallgrass prairie (NABCI 2009). Due to disappearance of grassland communities, grassland bird populations have been among the fastest and most consistently declining suite of species in North America over the past 40 years. Of the 46 North American grassland-breeding birds 55% have shown significant declines and 48% are of conservation concern including four which are federally endangered (NABCI 2009). Numerous studies and regional conservation plans point to the critical need of restoring and protecting large areas of native grasslands for breeding birds in order to save these threatened species.

Optimal conservation planning requires information on the distribution and abundance of species (Veloz et al 2015). We make use of a multi-year systematic survey by citizen volunteers to build models of avian abundance for five grassland bird species covering a range of habitat requirements: Bobolink, Sedge Wren, Henslow's Sparrow, Eastern Meadowlark, and Grasshopper Sparrow. Models estimate abundance based on landcover composition and configuration, soils, and vegetation condition. We then map relative abundance and estimate regional population sizes in support of grassland conservation efforts in the Chicago Metropolitan Region.

Grasslands also provision a variety of ecosystem services of interest to local managers. The spatially explicit quantification of ecosystem services is increasingly used as a method to demonstrate the economic value associated with the protection of natural areas (Polasky et al. 2011). We quantify the link between ecosystem services and grassland bird habitat using data from the Chicago Wilderness Green Infrastructure Vision (GIV). We summarize services such as water filtration, flood control, and carbon storage. In a GIS workflow, we identified patches of suitable habitat, calculated the estimated abundance of birds and valuations for each ecosystem service, and identified the proportion of each patch which is currently protected.

Abundance estimates (Table 1) suggest that of the five study species, Bobolink and Eastern Meadowlark are the most abundant grassland birds in the Chicago Metropolitan Region with estimates based on the performance-weighted mean of 20 abundance models greater than 50,000 individuals. Sedge Wren, Henslow's Sparrow, and Grasshopper Sparrow have estimated populations closer to 10,000 individuals. Uncertainty characterized by a performance-weighted coefficient of variation (CV) among models constructed with 20 bootstrapped datasets is greatest for the Grasshopper Sparrow (24%), Henslow's Sparrow (20%), and Sedge Wren (17%). For the two most common species, a majority of the population occurs in unprotected areas (Table 2). For the three remaining species, approximately half or more of the estimated population resides in existing protected areas.

Ecosystem services provisioned by grasslands across the CMAP region total in the millions (Table 3). Flood protection is the most valued resource, more than half of which comes from existing protected areas. In contrast, more than half of the current value in groundwater recharge, water purification, and in perpetuity through increased grassland protection.

The spatially explicit maps and outputs accompanying this work will inform future grassland conservation in the region. Audubon Chicago Region continues to work with county land management agencies to identify

Table 1. Abundance estimates for the Chicago Metropolitan Region.

Estimate	BOBO	SEWR	HESP	EAME	GRSP
Weighted Mean	**81,919**	**9,615**	**11,979**	**51,536**	**10,186**

Table 2. Counts and relative amounts of birds protected (P) and unprotected (U) in the entire CMAP region.

		Bobolink		Eastern Meadowlark		Grasshopper Sparrow		Henslow's Sparrow		Sedge Wren	
County	Status	#	%	#	%	#	%	#	%	#	%
CMAP	P	28,616	46%	12,183	36%	1,645	52%	3,435	74%	1,901	48%
	U	34,044	54%	21,229	64%	1,529	48%	1,231	26%	2,053	52%
Total		**62,660**		**33,412**		**3,174**		**4,666**		**3,954**	

Table 3. Totals for protected and unprotected acreage and ecosystem services.

Annual Ecosystem Service Value							
	Status	Acres	Flood Protection	Groundwater Recharge	Water Purification	Carbon Storage	All Services
CMAP	P	46,059	$359,548,415	$67,757,143	$40,197,377	$801,567	$468,304,567
	U	92,966	$298,228,956	$95,119,035	$45,034,743	$955,399	$439,338,078
Total		**139,024**	**$657,777,372**	**$162,876,178**	**$85,232,120**	**$1,756,966**	**$907,642,645**

areas for coordinated management and acquisition to promote grassland conservation in the Chicago Metropolitan Area.

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7. PRAIRIE POLLINATORS AND INVERTEBRATES

UNDERSTANDING POLLINATION AND HABITAT FRAGMENTATION IN NORTHERN GRASSLANDS.

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Pollination service by animals is a key ecosystem function which contributes to not only the reproductive success of most flowering plants, but also to maintaining biodiversity and ecological resilience. In North American grasslands, insects are the primary animal pollinators, and bees are the most important insect pollinators. Globally, bee diversity tends to be highest in semi-arid areas, including grasslands (Michener, 2007). In Canada, approximately half of all bee species are found in the prairie ecozone (Sheffield et al., 2014). In addition to ongoing domestic honeybee declines, many wild bee populations have shown decreases over the past decade (Cameron et al., 2011). Many wild bee species are not sufficiently well-monitored to have absolute information on population trends, but indirect evidence from habitat loss and agricultural intensification suggest declining populations (Potts et al. 2010).

Within this context of pollinator declines, it is important to understand how landscape configuration affects pollination and bees in grasslands. Changes in prairie landscapes include not only loss of grasslands, but also fragmentation of remaining grassland areas by roads and tree encroachment. Identifying the effects of fragmentation can be done by looking for edge effects: the ecological changes that happen near the boundary of different habitat types (Fahrig 2003). It is important to investigate the effects of fragmentation on insects since habitat management for larger wildlife does not necessarily ensure habitat conservation for grassland pollinators.

The main objective of this study is to determine if edge effects influence insect pollination service in fragmented Northern grasslands. To meet this objective, data was collected in grassland patches with road and tree edges in western Manitoba, Canada. To measure insect pollination service, phytometers (greenhouse-grown plants) were set at varying distances to edges, and their seed-set was then used as a proxy measure

for the amount of pollination they received. Sampling was also conducted for bee diversity and abundance, and vegetation structure and composition. GIS analysis was used to determine the landcover types within one kilometer of the research plots. Statistical analyses were conducted with generalized linear mixed effects models and generalized linear models.

Early results indicate that pollination service to the phytometers was not impacted by either tree or road edges at distances up to 150m. Rather, other variables at both the small-scale local level, and the large-scale landscape level were more important to pollination service. At the local level, within a 5 meter radius, bee abundance and diversity were positively associated with increased pollination service to the phytometers. Native flower diversity and abundance were also positively correlated with increased pollination service, while non-native flower diversity and abundance were not. These results suggest that native floral diversity is important for providing habitat for a diversity of bees, and thus facilitating pollination to the phytometer plants.

At the landscape level, an increasing percentage of crop landcover within 1 km of the research sites was strongly correlated with reduced pollination service to the phytometers, and was moderately correlated with reduced bee abundance and diversity. This may be due to bees' requirements for both foraging and nesting habitat (Westrich, 1996). Areas dominated by cropland are not only less likely to have floral resources for bees, but they are also less likely to provide a wide range of nesting habitats which would support diverse bee populations in an area (Williams et al., 2010). Since bees are mobile pollinators that forage a hundred meters to several kilometers from their nests, depending on the species, it is important to maintain sufficient nesting habitat in a region.

In sum, these results suggest that promoting and maintaining insect pollination service requires management that targets both local and landscape-level factors. The absence of detected edge effects may indicate that small grassland patches are essentially all edge-affected, but future research would be needed to confirm this.

There are several management implications of this research. The first is that it is clearly important to maintain local habitat diversity for bees and other pollinators. Activities such as grazing and controlled burns can help promote native flower diversity. As well, control of invasive species that reduce native plant diversity, such as smooth brome grass (Bromus inermis), can be important to promoting healthy pollination communities. Additionally, seeding of native flowers or other restoration work can help promote pollinator diversity in grassland areas. At the larger, landscape scale, management activities should take into account the amount of natural areas in a region. In grassland conservation initiatives, this could include regional plans to maintain a minimum percentage of natural areas, or careful selection of conservation properties that are surrounded by sufficient native habitats.

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RESPONSES OF A GRASSLAND SPIDER COMMUNITY TO HABITAT STRUCTURAL HETEROGENEITY DRIVEN BY FIRE AND BISON GRAZING DISTURBANCES INTERACTIONS

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An overarching hypothesis in community ecology is that increased habitat heterogeneity increases species diversity and species assemblage composition at multiple trophic levels across the landscape. In grassland ecosystems, interactions among fire, grazing, topography and climate create shifting mosaics of plant communities and associated habitat structural complexity. Accordingly, the habitat complexity and heterogeneity hypotheses predict that overall abundance and species diversity increases with spatial heterogeneity of habitat structure. We test the hypothesis that bottom-up, fire-grazing interactions structure ubiquitous and diverse spider assemblages create a shifting mosaic of habitats at multiple scales to drive the habitat heterogeneity/species diversity relationship.

Spiders are important predators in grasslands and provide an ideal ecological model to study how diverse predator assemblages respond to spatio-temporal variability in habitat structure driven by fire-grazing interactions. Unique long-term manipulations of fire frequency and bison grazing at watershed levels since 1972 have resulted in a mosaic of habitat types at Konza Prairie Biological Station. Spider and insect communities were sampled using sweep nets along a habitat gradient ranging from low-stature grass-dominated sites to gallery forest to test hypotheses related to structural heterogeneity. Spider species richness increased over the growing season. Spider abundance and species richness increased with increased time since the last fire and moderate to low bison use of the sites. In general, spider abundance and diversity increased with increasing habitat structural complexity and heterogeneity from grass dominated sites to those with a greater mixture of grasses, forbs and woody vegetation in response to fire-grazing interactions. The transitional ecotone between grasslands and woodlands supported a hotspot for spider abundance and species richness. The mosaic of grassland types from unique long-term watershed level manipulations of fire frequency and bison grazing at KPBS sustain multiple, distinct spider species assemblages, supporting the conclusion that habitat structural heterogeneity is critical for maintaining diversity in these important invertebrate predator assemblages.

EVALUATING BEE DIVERSITY IN RANGELAND AND CROPLAND WITH POLLINATOR HABITAT STRIPS

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Native and managed bees provide critical pollinator services to natural and agroecosystems. The mutualistic relationship between plants and pollinators is at serious risk largely due to habitat degradation, parasites and pesticides. While much attention is directed at honeybees, native bees also experience debilitating effects from these factors. As agricultural landscapes became monocultures, floral resources and nesting habitats for bees declined exponentially. The 2008 Farm Bill recognized these declines and prioritized the conservation of pollinator habitats

through USDA (United Stated Department of Agriculture) programs such as the Pollinator Habitat Initiative, which incentivizes planting of native flora to encourage native pollinators.

In collaboration with USDA, the United States Geological Survey (USGS) is comparing pollinator diversity in Conservation Reserve Program (CRP) fields with and without pollinator habitat strips, within fields surrounded by rangeland or cropland cover. *In this presentation we reported the comparison of bee pollinator diversity in experimental plots with and without pollinator habitats.* Using sweep nets and blue vane traps, bees were collected during 2012 and 2013 summers. Over 5,500 bee specimens were gathered representing 48 genera and 65 species with 26 species not previously recorded from Logan County, Colorado. Preliminary data analyses indicate a significant effect of land type on H, the Shannon Weiner diversity index (ANOVA: F1, 8=6.85; p=0.03), with rangeland (H=2.08) being higher in diversity than cropland (H=1.77). Analysis of combined data from CRP fields within rangeland and cropland did not indicate a significant effect of pollinator habitat plantings on the diversity index (ANOVA: F1, 8=1.95; p=0.2). Analysis of the subset of data from CRP fields around cropland indicated that H values were not affected by pollinator habitats (ANOVA: F3, 6=2.62; p=0.14), with diversity index for fields near cropland with pollinator habitat (H=1.81) being similar to that without (H=1.72). These results provide limited evidence that supplementing pollinator habitat plantings improve bee diversity.

A combination of factors including biology of bees, their interactions with agroecological landscapes and the range of nutritive and nesting benefits offered by plant species need further investigation to understand factors promoting bee diversity. Implications of these results for effective pollinator conservation strategies were discussed.

PARTNERING TO CONSERVE THE MONARCH MIGRATION: THE MONARCH JOINT VENTURE

Wendy Caldwell, Monarch Joint Venture

The Monarch Joint Venture is a national conservation partnership which was formed in 2009 to conserve the monarch butterfly migration in the U.S. The MJV has over 30 dedicated partners ranging from federal agencies to nature centers who are working diligently to protect monarchs by restoring or enhancing habitat, educating others, and researching and monitoring to better inform conservation efforts. The MJV is a unique partnership, following the Joint Venture model. It is guided by the North American Monarch Conservation Plan and overseen by a steering committee of partner representatives. A primary goal of the MJV is to restore habitat not only for monarchs, but other pollinators and grassland species as well. Habitat that is critical for supporting monarch population numbers will also benefit a diverse suite of other species. Under the umbrella of the MJV, partners are engaging many stakeholders, including farmers, ranchers, public land managers, and other private landowners in an effort to restore milkweed and other nectar sources for pollinators in different landscapes. Milkweed is the only plant which monarch caterpillars can eat and is native to grasslands throughout the country, and therefore restoration of native milkweeds is a primary focus of the MJV, in grasslands and in other landscapes where milkweed can thrive. Through a coordinated effort, MJV partners are effectively and efficiently advancing large scale efforts to conserve monarchs and their habitat. This successful model engages various stakeholders to take action in not only restoring habitat, but also monitoring and reporting scientific observations on a large geographic scale. As interest surrounding the monarch butterfly continues to grow, the Monarch Joint Venture partnership will help to deliver the best science and conservation for an iconic species.

CREATING A STATEWIDE MONARCH & POLLINATOR STRATEGY: A REPORT-OUT FROM THE MISSOURI MONARCH SUMMIT

Carol Davit, Missouri Prairie Foundation

Dramatic declines in the population of the monarch butterfly *(Danaus plexippus)* promoted requests in September 2014 from the Xerces Society of Invertebrate Conservation, the Center for Biological Diversity, and monarch specialist Dr. Lincoln Brower to the U.S. Fish and Wildlife Service to consider listing the monarch butterfly as a threatened species under the federal Endangered Species Act.

In February 2015 the National Wildlife Federation (NWF) and U.S. Fish and Wildlife Service sign a memorandum of understanding to work on public engagement strategies. In March 2015 NWF contacted the Missouri Prairie Foundation (MPF), a nonprofit prairie conservation organization about identifying participants to attend a summit in Missouri with the goal of developing a statewide habitat enhancement strategy for monarchs and pollinators. NWF and MPF soon begin having phone meetings weekly along with representatives from the Conservation Federation of Missouri and the Missouri Department of Conservation to begin coordinating the summit, its participants, format, and goals.

Between May and July 2015 this core group raised about $10,000 in funds to hire a pre-summit and summit facilitator, Brooking Gatewood of Ag Innovations in California. (Some of this funding was left over and used to pay for post-summit facilitated steering committee meetings.)

On July 13, 14, 2015, 47 people representing 32 groups convened for two days at the University of Missouri–Columbia to begin a collaborative effort to support monarch and pollinator habitat enhancement in Missouri. Participants included representatives from corn and soybean grower associations, electric cooperatives, private landowners, nongovernmental organizations and "citizen science" groups, Monsanto, Monarch Watch, state and federal public agencies, and landscaping industry and seed producers.

The solutions approach to the Missouri Monarch and Pollinator Summit Approach was that of "no stone left unturned": Summit participants analyzed all possible land that could be part of the solution—from backyards to agricultural fields to utility corridors. They identified as many challenges as possible, from seed supply to land management, and as many potential players as possible. The Summit participants checked all their logos at the door, focused on what they could accomplish at the state level, and worked together with the understanding that no sector would be criticized for the current plight of monarchs and many pollinators.

Priority focus areas for the collaborative included: areas for habitat creation/enhancement (i.e., state lands, large private acreages and ROW corridors); increasing the general public's understanding of the plight of monarchs and pollinators; the value of ecosystem services to human well-being and how citizens could participate in sustaining/increasing populations; and the availability of seeds and plants, coordinated site identification, consistent messaging, mapping of results, and changing the "aesthetic eye" of the average citizen were also foundational for the efforts of the Collaborative.

Key steps after the summit were the creation of a statewide steering committee (all Summit participates were invited to serve on the steering committee, with about half committing to doing so), establishing a vision and mission statement, developing a monarch and pollinator conservation strategic plan, and hiring a coordinator.

Immediate activities to be undertaken by the Steering Committee and collaborative, to focus on marketing/education/outreach include creating/recruiting a marketing work group, creating a Memorandum of

Understanding for the collaborative partners, creating a targeted public outreach strategy, identifying press and lobbying efforts/needs, and creating an improved Missouri monarch publication.

Immediate tasks of the steering committee when it first formed included creating a vision and mission statement, a communications plan, a process oversight group and charter, carrying out fundraising, budgeting for future work, and establishing a fiscal agent. Missouri is eager to share its strategies for success with other states—to assist with success throughout the monarch breeding range and migratory flyway.

Photo Credit: Noppadol Paothong.

8. ENERGY DEVELOPMENT IN GRASSLANDS

UNDERSTANDING THE FUTURE OF WIND DEVELOPMENT IN MONTANA AND WYOMING

Claire Hood, World Wildlife Fund

Wind energy in the United States has grown substantially between 2000 and 2015, thanks in part to the Production Tax Credit and other federal policies meant to foster industry growth. Wind contributed 4.9% of the country's electricity in 2014 and is cost competitive with coal and fossil fuels in many parts of the country (Wiser and Bolinger 2015). Technological advances and manufacturing growth continue to reduce costs and make turbines more efficient and powerful. Wind's presence on public lands has also increased in the last decade with 57 projects approved on BLM lands since 2009. President Obama's Climate Action Plan has propelled multiple land management agencies

to make federal lands more appealing for development by simplifying permit processes and identifying potential areas specifically for renewables. While wind development on public lands is still relatively minimal, it is likely to increase in the coming years as additional incentivizing policies are enacted and the country shifts away from coal and fossil fuels.

This growing national development led the World Wildlife Fund's (WWF) Northern Great Plains (NGP) program to ask how the development of wind energy and transmission intersect with WWF's goal of sustaining intact grasslands and enhancing biodiversity in the NGP. My research has aimed to address this question while developing an official position for WWF on wind development in our ecoregion. I first researched wind energy growth nationally and in Montana to determine development trends, drivers, and impacts of wind as well as variables that could affect future growth. Next, I took an in-depth look at wind development in Wyoming, comparing it to Montana and determining how state and economic policies, as well as geographic location, can affect wind energy growth. I then conducted case studies of three Montana wind farms to elucidate how developers vary in project siting, conducting environmental analyses, mitigating potential environmental concerns, and working with conservation groups. Together, this research led to a position paper on wind development in the NGP, which advocates for smart landscape-scale planning, siting and construction BMPs, and development in low-impact areas.

In this presentation, I explained that, while Montana wind projects have increased in the last decade, the pace of development has lagged behind other states with similar levels of wind potential. Despite offering some of the highest wind potential in the United States, Montana ranks 21st for installed capacity (AWEA 2014a). This discrepancy can be attributed to a lack of transmission and a lack of demand (both within the state and across the West), two issues that are interconnected. Further stymying development is Montana's geographical location in relation to other wind-rich states in the Northwest and within the national grid. These impediments have largely trumped the state's efforts to draw developers to Montana (namely the Renewable Portfolio Standard and a general lack of regulation around wind). Development on Montana public lands has also trailed other Western states. No projects are currently constructed or proposed on federal lands; in fact, the BLM Montana field office has not received a single permit application for construction. Only one project, Judith Gap, is constructed on public (state) lands.

Alternatively, wind development in Wyoming is not impeded by the same issues. Wyoming's installed wind capacity is more than double that of Montana (1410 MW versus 665 MW) (AWEA 2014a,b). Despite a pause in new projects over the last five years, the state represents one of the largest hubs of wind development in the Northwestern United States. Wyoming has two major projects under development and over 10,000 MW in transmission planned over the next ten years. Yet state policies do not actively encourage wind; in fact, they seem to create an anti-wind regulatory environment where wind is taxed and the rights of landowners are prioritized. The state's lack of a Renewable Portfolio Standard shows that, while a renewable energy mandate or goal can spur development, it certainly is not necessary for its success. Wyoming's advantage comes down to the same two issues that have impeded more development in Montana: available transmission and demand. Wyoming's geographical location allows it to reach areas of high demand more easily. While markets Montana delivers power to are not currently demanding more renewable energy, California and parts of the Southwest continue to need more. Wyoming is better situated to meet those needs in terms of planned transmission capacity and simple proximity. Until markets in the Northwest demand more clean energy, developers in Montana will not have the support for new transmission lines and in turn new wind projects, regardless of whether they are on private or public lands.

Next, I presented the findings of the Montana wind farm case studies. Wind energy is often portrayed as a green form of energy with minimal environmental impacts, and wind developers promote this position when

proposing new projects. However, while wind energy does reduce greenhouse gas (GHG) emissions and water usage typical to fossil fuels, it can have a large environmental footprint and negatively affect local wildlife. Several species native to the NGP, including greater sage grouse, grassland birds, raptors, and bats are known to be sensitive to wind development. In addition to directly causing bird and bat fatalities, a wind project can have indirect wildlife impacts such as the introduction of invasive species, increased predation, and habitat avoidance. It can also result in habitat loss and fragmentation. A project's footprint can vary depending on the perimeter measured around all turbines, the surrounding terrain, and the different methodologies used across studies. Land use change from wind energy is similar to traditional energy sources when considering that much of the land between turbines can still support other land uses or function as wildlife habitat for some terrestrial species. However, when considering the entire wind project, land use can increase to between 50 and 200 m2/MWh (Hertwich et al. 2014). Turbine pads generally make up 10% of a project's land impact while access roads make up a staggering 79% (Denholm et al. 2009). Thus, while wind energy does reduce GHG emissions and water usage, it can have a large environmental footprint.

These impacts can vary greatly depending on the size and siting of the project. For example, a large project constructed on undisturbed grasslands near a ridgeline can have detrimental impacts, including habitat loss and fragmentation as well as possible raptor fatalities due to its nearness to habitat. In this way, a project's environmental impacts are determined to some extent by the developer and his or her willingness to work with scientists and conservationists to minimize a proposed project's impacts. The Montana case studies found that three wind farms in the state (Judith Gap Wind Farm, Glacier and Rimrock Wind Farms, and the proposed Mud Springs Wind Ranch) have responded to environmental concerns in different ways. I conducted interviews and site visits when possible to learn more about each project, its history, and its efforts to mitigate environmental issues. After reviewing these projects, it is clear that wind developers can vary widely in how they address environmental issues.

Several variables could alter future wind development in the NGP. Federal policies, such as the Clean Power Plan, could require states to turn away from coal and rely more on renewables. Increases in state Renewable Portfolio Standards or reauthorization of the national Production Tax Credit could also spur development. Alternatively, increasing energy efficiency or congressional efforts to limit the spread of renewables could slow industry growth. Lastly, upgrades to and expansion of the national grid could spell better integration of wind into the power system and increased transmission capacity. These efforts, paired with new demand, could drive development across the Western United States.

Lastly, I presented details on WWF's official position on wind energy in the NGP. This position aims to balance wind energy's role in combatting climate change with its landscape impacts. It advocates for no wind projects constructed on or near intact landscapes or sensitive species in the NGP. It promotes full consideration of alternatives and best management practices before project siting, construction, and operation. Lastly, it supports the application of principles, tools, and inclusive, transparent processes in order to make the best possible choices regarding the development of new projects.

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ROLE OF ETHANOL PLANTS IN DAKOTAS' LAND USE CHANGE: ANALYSIS USING REMOTELY SENSED DATA

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The purpose of this study is to better understand the role that ethanol plants have had in land use changes that have occurred in North and South Dakota over the past decade. Many recent studies have found that large areas of grasslands have converted to crop-based production systems, especially corn and soybeans, after 2006. A net of 271,000 hectares of grasslands were estimated to have been converted for cropping during 2006-'11 (Wright and Wimberley, 2013), almost seven times the 36,450 hectares grasslands estimated to have been converted during 1980-2003 (Stephens et al. 2008). Johnston (2014) has concluded that the combined acreage of corn and soybeans tripled between 1980 and 2011. Lark et al. (2015) shows evidence that the Dakotas have experienced the greatest increase in new cultivated land among all areas east of the Missouri River during 2008-'12.

We consider the localized land use impacts of ethanol plants to evaluate whether they have contributed towards accelerated grassland conversions in this region. This is relevant for two reasons. First, while inquiries have characterized land-use changes for these states, formal analyses to establish causal factors for pertinent conversions are lacking. Our analysis of the localized land use impacts of Dakotas' ethanol plants is a first step in this direction. Second, all of the nineteen Dakotas' ethanol plants are corn-based and fifteen of these started operations during 2006-'08, after the Renewable Fuel Standards under the Energy Policy Act (2005) came into effect. This period also coincides with the aforementioned rapid grasslands conversions in this region. Therefore, our inquiry on the impact of ethanol plants on the increased corn acreage in the Dakotas also potentially evaluates the regional impact of a national policy.

An understanding of economic incentives to grow corn in proximity of an ethanol plant is fundamental to evaluating their impacts on land use. The advent of corn-based ethanol plants increases annual demand for corn in the locality. Landowners that are located near these ethanol plants would incur lower transportation costs to supply their corn produce to these demand terminals. These lowered transportation costs are potentially reflected in generally higher post-2008 corn prices in counties where Dakotas' ethanol plants were established, compared to their pre-2006 levels.[1] These increased prices received by local corn producers are referred to as the economic incentives for supplying corn to near-by ethanol plants. Such incentives could trigger intensified corn cropping over traditionally grass acres, consistent with changes in aggregate land use identified by earlier studies. So our inquiry about the land use impacts of ethanol plants primarily evaluates whether proximity to these plants has led to increased corn production.

Since changes in incentives due to the location of ethanol plants are local, we model land use decisions in neighborhoods around these plants. We utilize Euclidean distance between land units and an ethanol plant to differentiate between transportation costs. We

[1] The inference about 'generally higher corn price' is based on our observation of time-series plots of corn basis that suggest a stronger basis after 2008. Stronger corn basis (i.e., local price minus futures price for delivery at some distant location) is due to increased local corn price relative to corn futures prices.

find empirical evidence that transportation costs are of sufficient magnitude to expect meaningful impacts on land use choices. The difference in transportation costs in supplying corn to an ethanol plant from two locations that are 50-miles apart is equivalent to almost 14%-47% of the agricultural land values in these states, which should incentivize more rapid conversion to corn acres on land parcels located at shorter distances from the plant than the ones located farther away.

We employ a unique research design that uses a quasi-experimental framework to evaluate the localized land use impact of ethanol plants. For this purpose, we construct a spatially delineated panel dataset containing multi-year land use statistics (1997-2013 for North Dakota and 2006-'13 for South Dakota), time-invariant soils quality measures and ethanol plant coordinates. Remote-sensing tools are employed to combine spatial data layers from NASS CDL's CropScape, NRI's STATSGO2 and ethanol plants' spatial coordinates from Google Earth. Our high-resolution dataset allows us to allocate 500-acre land parcels as representative decision-making units, unlike most prior studies that have used coarser-data with counties as decision-making units. Further, the ethanol plants are viewed to be individual treatments for this study. This allows us to estimate land use impacts separately for each ethanol plant, unlike a single region-level impact estimate as is typically found in the literature.

The methods employed are Difference-in-Differences (DID) and Propensity Score Matching (PSM). Specifically, we compare land tracts that differ by proximity to an ethanol plant. The treatment group consists of land parcels that are located closer to the ethanol plant than the control parcels, implying lower transportation costs and higher incentives to grow corn on treated parcels. DID analysis provides an estimated average treatment effect by comparing differences in outcome upon treatment for a treatment group with that of a control group. However, the land parcels we compare may differ in attributes other than the distance to plant. We use PSM to address this concern by controlling for land quality and slope characteristics.

We estimate the impacts of ethanol plant by implementing a standard DID model that utilizes the Parallel Paths assumption on how treated land would have changed over time had it not been treated. We find that the impact on corn acres varies by their sign, magnitude and statistical significance across different ethanol plants. However, we find positive as well as negative effects of ethanol plants on corn-acres. Negative treatment effects are surprising, and also difficult to reconcile with the higher incentives to grow corn in treated parcels. So a single point estimate for all ethanol plants in a region, as usually provided in the literature, can be highly misleading. We also find that corn production intensified relative to corn-soy rotations due to proximity to the ethanol plants. In addition there is evidence that opportunity costs of converting from wheat differ from those of converting from grass to corn.

We further investigate the identifying Parallel Paths assumption of the standard DID model and infer that it fails to hold. We update our estimation framework to a generalized DID framework that incorporates differentiated trends among treatment and control groups. The updated framework also finds both positive and negative ethanol plant impacts. We conclude that, although our research framework allows us to analyze ethanol plant impacts at a local level, identifying these localized impacts is challenging. Even though we do not find definitive ethanol plant impacts, we find strong incremental trends in corn acres for all land parcels after the 2006-'08 period. Therefore, failure to detect a local effect is not inconsistent with the existence of a national-level effect of ethanol policies resulting from higher national commodity prices.

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RECENT CROPLAND EXPANSION CONCENTRATED AROUND ETHANOL REFINERIES SUGGESTS A GAP IN US REGULATION OF BIOFUEL FEEDSTOCK SOURCING

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We used fine-scale agricultural land cover information from the US Cropland Data Layer to assess cropland expansion surrounding all actively producing corn ethanol refineries in the US (as of 2009) during initial implementation of the Energy Independence and Security Act (EISA) from 2008-2012. Aggregate conversion rates on potentially arable land declined linearly from 2.7% at 0-25 miles distance from all US ethanol refineries to 1.2% at 75-100 miles distance. Within 50-miles of ethanol refineries, a nominal feedstock draw area for these facilities, we found 2.3-million acres of non-cropland converted to cropland. Land cover land use change (LCLUC) occurred primarily in grass-dominated land cover types. Corn and soybeans were the primary break-out crops but the relative proportion of new cropland in small-grains increased beyond 50-miles distance from refineries. We propose an alternate approach to monitoring compliance with feedstock sourcing standards under EISA based on LCLUC analysis at the appropriate spatial scale and improved classification of grass-dominated land cover types.

MOUNTAINS TO PLAINS ENERGY BY DESIGN: COLLABORATIVE OIL AND GAS PLANNING TO PROTECT WILDLIFE, HABITAT, AND CULTURAL VALUES

Megan Kram, The Nature Conservancy

With leadership from The State Land Board, based on The Nature Conservancy's Energy by Design methodology, a report was developed which identifies priority biological, cultural, scenic, and recreational resource values within 60,000 acres in northeastern Colorado. The report also recommends strategies to avoid, minimize, and offset the potential impacts of oil and gas development to these values. The process undertaken in developing the report provides an example of collaborative energy planning between federal, state, and local governments, a mineral owner (Colorado State Land Board), and nonprofit organizations.

The SLB sought a process to design an oil and gas leasing plan that would consider energy development with the conservation goals of local governments. Under contract with the SLB, The Nature Conservancy led this project working closely with the SLB, the City of Fort Collins, Larimer County, and with input from a Technical Team. The report identifies recommendations to the SLB for surface restrictions across the Project Area, including areas for avoidance, minimization of impacts, and preferred areas for oil and gas development (figure 1). It also provides guidance for timing limitations for biological resources, restoration standards, and possible compensatory mitigation to aid the SLB in its creation of an Oil and Gas Leasing Plan.

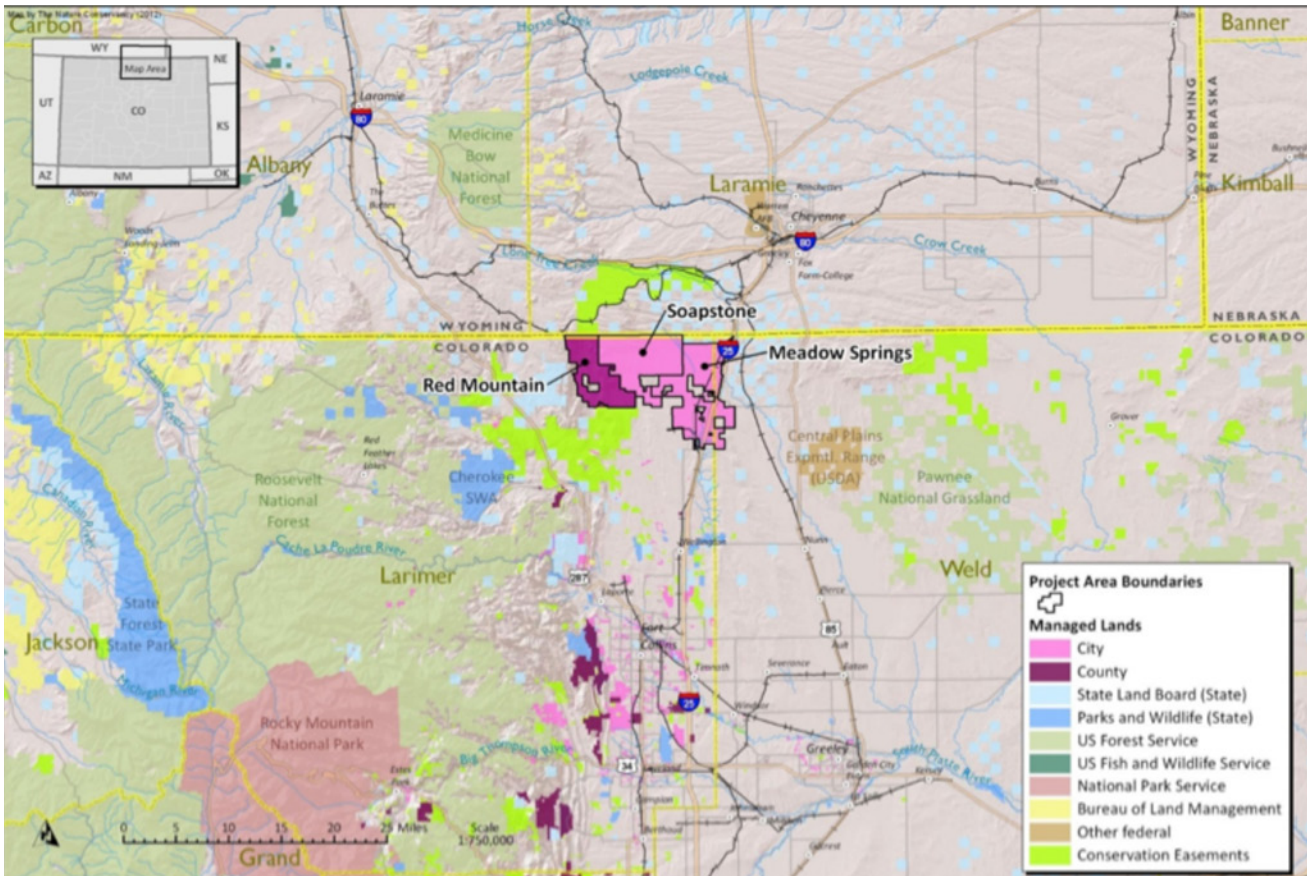


Figure 1. Project Area.

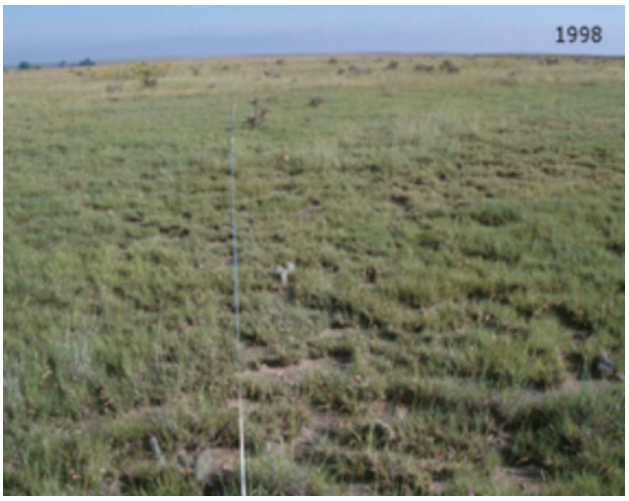
9. CLIMATE CHANGE AND THE FUTURE OF GRASSLANDS

VEGETATION RESPONSE TO EXTREME DROUGHT IN A COLORADO GRASSLAND-SHRUB COMMUNITY: IMPLICATIONS FOR THE FUTURE OF SHORTGRASS PRAIRIE

Karin Decker, Colorado Natural Heritage Program

Other Authors: Renée Rondeau, Devanshi Kukadia, Georgia Doyle, Abigail Bradley, Colorado State University

Drought is a recurrent local and regional event throughout North America, as demonstrated by both historical instrumental measurement, and by other evidence for previous centuries. Shortgrass species have evolved under drought, and are generally believed to be resilient to this disturbance. Projections for changing climatic conditions are largely in agreement that future conditions for the shortgrass region will be warmer, and are likely to include increased frequency



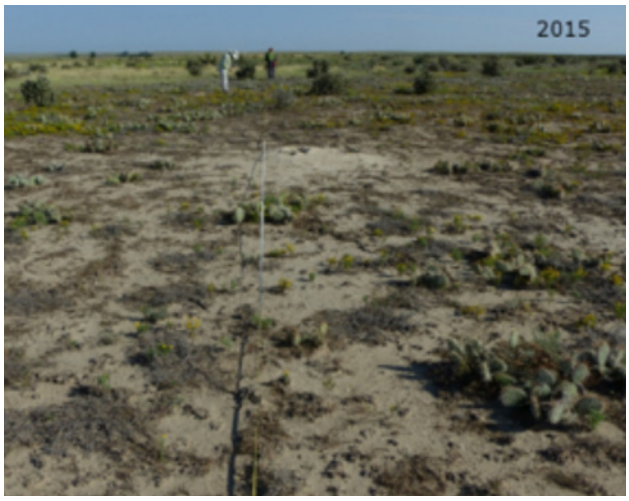


Photo Credit: Colorado Natural Heritage Program.

and intensity of drought. We presented vegetation monitoring results from a 15-year long period that includes two regionally significant drought years (2002 and 2012) coupled with temperatures 1°C warmer than average. Our study site includes 13 shortgrass plots at Pueblo Chemical Depot (PCD) in southeastern Colorado (details in Rondeau et al. 2013).

Two primary trends were evident in data collected between 1999 and 2015. First, the characteristic shortgrass species blue grama *(Bouteloua gracilis)* declined in both cover (-56% since 2001) and frequency (-51% in the same period). Although some post-drought grassland recovery was observed, the decline continued after the second drought. At the same time, the shrubby succulent cholla *(Cylindropuntia imbricata)* has increased in both cover (+196% since 2001) and density (+46% in the same period).

The shortgrass prairie at PCD has undergone a significant change, starting with the 2002 drought. The overall trajectory of this site appears to be toward a semi-desert shrub steppe. Although no data were collected between 2010 and 2015, we suspect that the drought years of 2011-2012, and high temperatures in 2013 may have contributed to the continued decline of blue grama. Past experience leads us to suspect that true recovery of blue grama at this site may require 5 or more years of above average precipitation.

This site is representative of the warmer, drier margin of current shortgrass distribution, and thus serves as a window onto potential future conditions for shortgrass prairie. Current climate projections indicate that the prairie region can expect extreme and extended droughts coupled with high temperatures in the future (Cook et al. 2015).

We suggest that our study supports a probable future decline of blue grama as a dominant species in the shortgrass prairie, with a consequent shift in overall species composition. Grasses most likely to do well in future conditions include sand dropseed *(Sporobolus cryptandrus),* alkali sakaton *(S. airoides),* James' galleta *(Pleuraphis jamesii)*, and threeawn (*Aristida* spp.). None of these are as nutritious to cattle as blue grama, thus, ranches that rely on blue grama as a dominant feed, may see a decline in the grazing capacity of their ranges.

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MANAGING HABITATS IN A CHANGING CLIMATE: SERENDIPITY OR STRATEGY? THE FIRST NATIONAL SEED STRATEGY

Tanya Skurski, Bureau of Land Management

Other Authors: Peggy Olwell, Bureau of Land Management

Large-scale disturbances and other stressors threaten important plant communities and the ecosystem services they provide on Federal, state, local, and private land. These stressors include the spread of invasive plant species, altered wildfire regimes, habitat modification, and climate change. There is an urgent need to be able to respond quickly to restore lands impacted by these landscape-scale ecological changes with the appropriate resources for all land ownerships across the United States. The "National Seed Strategy for Rehabilitation and Restoration 2015-2020" (Strategy) will help meet the increasing demand for seeds to restore plant communities altered by natural or human caused events on both public and private lands across the U.S. The strategy will provide a more coordinated approach for stabilization, rehabilitation, and restoration treatments by engaging tribal, state, federal, local and private partners in working together toward the Strategy's goals. It provides a framework for actively working with the private sector to increase the availability of the most appropriate seed for a given location. Increased coordination between and among the private and public sector is vital to accelerate the pace and scale of rehabilitation and restoration.

Seed is a critical natural resource that has been largely unrecognized, unprotected, and undermanaged. Our nation's seed resources are in need of the same kind of forward-thinking management we demand for other natural resources such as wildlife and timber. Locally adapted seed sources are critical for restoration and management of different ecological regions. Restoring native plant communities on a landscape scale poses special challenges. Land managers must often replant large acreages quickly to avoid severe erosion or colonization by nonnative invasive plants. Adding to the challenges are the expense and difficulty of obtaining and delivering adequate quantities of appropriate seed

to meet the need, which is often difficult to predict. For successful rehabilitation and restoration, this seed must be available for use at the right time and in the right place.

The National Seed Strategy is a collaborative effort of the Plant Conservation Alliance (PCA) **(http://www.blm.gov/pca)**, representing more than 300 private and public organizations. The PCA Federal Committee, composed of 12 agencies, developed the strategy as requested by participants of a June 2014 National Seed Conference in Washington, DC. As chair of the Federal Committee, the BLM took the lead in organizing this cooperative Strategy. With almost 30 percent of U.S. lands under Federal management, this Strategy encourages large-scale habitat restoration. Smaller scale restoration on Federal lands will also benefit from large-scale public investment in commercial native seed production. The Strategy is national in scope and engages both Federal and non-Federal partners working toward restoration on public, tribal, state, municipal, and private lands. While the Strategy will be renewed in 5-year cycles, its actions will affect landscapes and habitats far into the future.

Success on a national scale will be achieved through coordinated establishment of a nationwide network of native seed collectors, a network of farmers and growers working to develop seed, a network of nurseries and seed storage facilities to supply adequate quantities of appropriate seed, and a network of restoration ecologists who know how to put the right seed in the right place at the right time. Achieving this will require additional investments, research, improved decision tools, and enhanced communication.

Vision

The right seed in the right place at the right time.

Mission

To ensure the availability of genetically appropriate seed to restore viable and productive plant communities and sustainable ecosystems.

Goal 1: Identify seed needs, and ensure the reliable availability of genetically appropriate seed.

The ability of land managers to respond effectively to both emergency and planned restoration needs—and to advance ecological management and research activities—is highly dependent on the reliable availability of genetically appropriate seed. Actions under this goal will assess seed needs and fulfillment capacities, with an eye toward targeting infrastructure investments, increasing coordinated wildland seed collection and field production, and expanding cooperation and partnerships within and among public and private sectors.

Goal 2: Identify research needs and conduct research to provide genetically appropriate seed and to improve technology for native seed production and ecosystem restoration.

The use of native plants to restore disturbed communities is essential to provide diversity, improve ecosystem functioning, facilitate adaptation to climate change, and meet management objectives. To ensure that adapted plant materials are available to provide long-term sustainability, actions under this goal will identify and conduct research on developing and testing seed zones; develop reliable protocols for seed testing, storage, and production; and define effective restoration strategies and monitoring systems.

Goal 3: Develop tools that enable managers to make timely, informed seeding decisions for ecological restoration.

Managers and decision makers are often faced with uncertainty and having to work with incomplete information and varying availability of native plant materials. New tools are needed to help managers assess the risks, guide the scope, and predict the efficacy of restoration treatments. To help meet this

need, actions under this goal will synthesize research on native species ecology and develop tools to access, communicate, and apply relevant knowledge. Specific objectives include developing training programs for practitioners, producers, and stakeholders on using genetically appropriate seed for restoration, developing native seed source availability data and tools for accessing the data, and developing and integrating science delivery tools to support restoration project development and implementation.

Goal 4: Develop strategies for internal and external communication.

Successful implementation of this Strategy will require broad communication and outreach to engage agency staff and stakeholders in the shared goals of the Strategy. Both Federal and non-Federal partners play an important role in achieving the Strategy's goals and will need communication materials tailored to key audiences. An emphasis on feedback, evaluation, and improvement of the Strategy will help ensure it remains relevant and responsive to evolving needs. Actions under this goal will include communicating and reporting progress, recognizing achievements, and revising the Strategy based on assessments and feedback.

The Strategy provides guidance for, and implements, a number of major national initiatives including, the President's Climate Action Plan, the National Fish, Wildlife & Plants Climate Adaptation Strategy, the National Strategy to Promote the Health of Honey Bees and Other Pollinators, Interior Department Secretarial Orders 3330 on mitigation and 3336 on rangeland fire, and Executive Order 13112 on invasive species.

For more information and to download the National Seed Strategy please go to: **http://www.blm.gov/seedstrategy.**

NEW CARBON OFFSET PROTOCOL FOR GRASSLAND CONSERVATION

Max DuBuisson, Climate Action Reserve

Long-term grassland in the United States is under increasing threat due to conversion to cropland. Such conversion causes significant emissions of greenhouse gases (GHGs) in the form of soil carbon loss and emissions from crop cultivation (related to fertilizer and fossil fuel use). Because of these GHG impacts, financing from the carbon market can be used to leverage other conservation dollars in order to permanently protect grassland and grazing land. Carbon offset protocols and registries are the mechanisms by which GHG reduction activities can gain access the carbon market. Until now, access for grassland conservation projects involved prohibitive transaction costs. The Climate Action Reserve has just completed public development of a streamlined methodology which balances methodological rigor with a user-friendly approach which will alleviate some of the high costs of market access. Details about this protocol and the development process can be found here: **http://www.climateactionreserve.org/how/protocols/grassland/.**

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 72 million offset credits (tonnes of CO2e) to hundreds of projects across the U.S. and Mexico, and has adopted 17 different project protocols.

The carbon markets are a tool which can be leveraged for the financing of grassland conservation in areas where grassland is threatened by conversion to crop cultivation. For landowners which are interested in long-term conservation of their grassland, the Grassland Project Protocol v1.0 is very straightforward to use. The Reserve has developed a quantification tool to handle the GHG calculations, and will be developing additional tools and resources to further lower the

Dakota grassland being prepped for cultivation. Photo Credit: Ducks Unlimited.

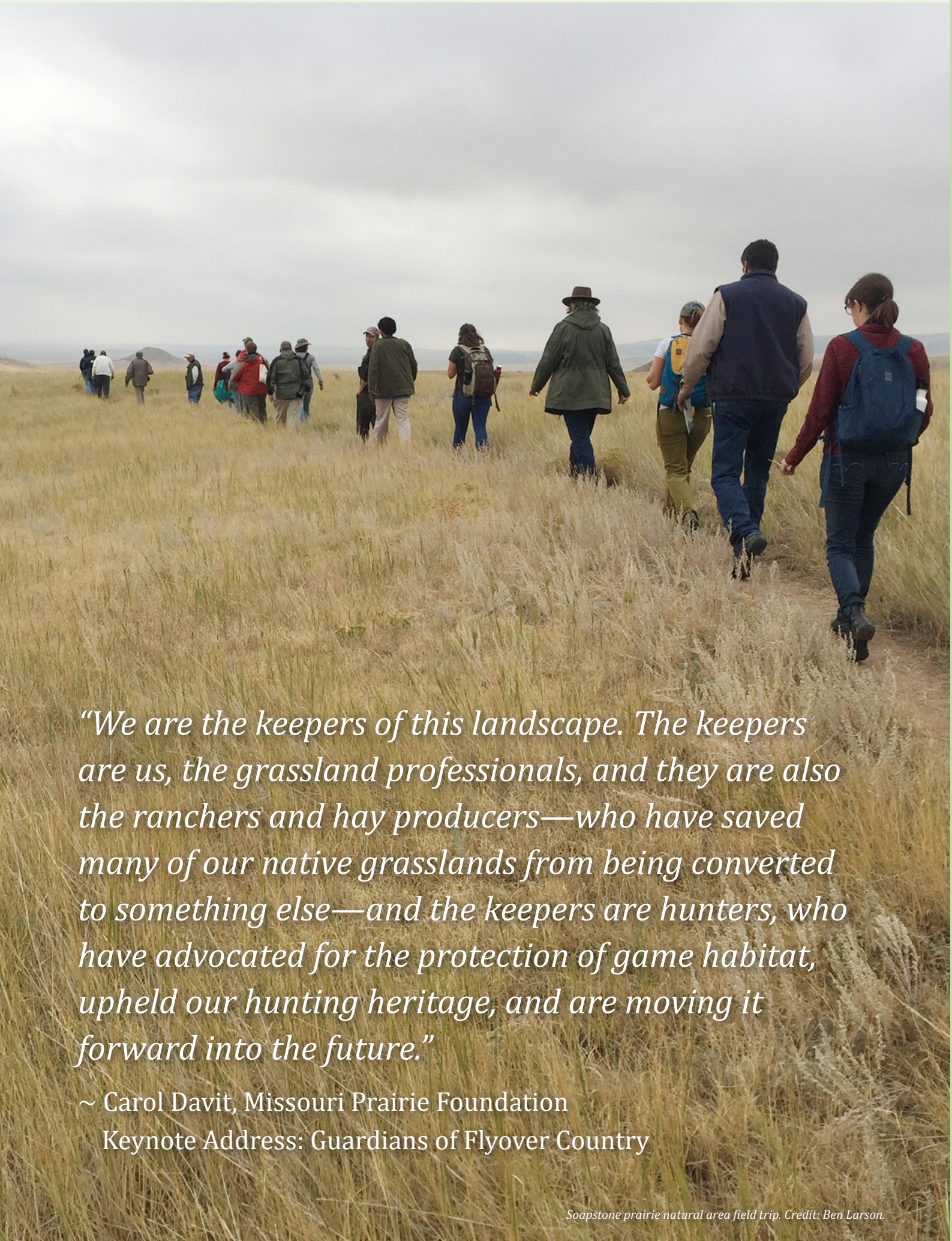
barriers to implementation of these projects. Grassland projects are currently able to access buyers in the voluntary carbon market, but the Reserve will continue to work with the California Air Resources Board to support the potential development of a compliance offset protocol for avoided grassland conversion. The CA compliance offset market presents a stable market with high demand for land-based offset credits.

GRASSLANDS AND CARBON MARKETS: OVERVIEW, OPPORTUNITIES, AND REALITIES

Billy Gascoigne, Ducks Unlimited

Market-based mechanisms are continuously touted as a means to generate additional revenue from natural landscapes and further conservation. For the most part, formal market structures have been lacking for environmental goods and services and/or refined to small geographic areas (e.g. individual watersheds). Carbon offset (or "credit") markets are some of the more established environmental markets in the U.S. and abroad. While these markets have had a tumultuous history, more recently the voluntary marketspace has remained relatively stable, and in 2013, the U.S. had its first regulatory carbon market emerge out of the state of California.

Ducks Unlimited, Inc. (DU) has a long history of investing in grassland systems that provide vital breeding habitat for migratory waterfowl. Much of the breeding habitat valued by DU is under threat to conversion to row-crop production. With the understanding that this land conversion also has significant carbon implications, DU led development of the Avoided Conversion of Grasslands and Shrublands (ACoGS) carbon offset protocol that was formally approved by the American Carbon Registry in 2013. As such, DU recently generated the first-ever certified ACoGS credits in the world and sold them to Chevrolet in a landmark transaction. While this project was a success in many regards, there remain significant challenges to carbon credit generation from grasslands and overall market expansion. This presentation will provide an overview of the carbon markets, outline past successes and future opportunities, and discuss the inherent challenges that remain.



"We are the keepers of this landscape. The keepers are us, the grassland professionals, and they are also the ranchers and hay producers—who have saved many of our native grasslands from being converted to something else—and the keepers are hunters, who have advocated for the protection of game habitat, upheld our hunting heritage, and are moving it forward into the future."

~ Carol Davit, Missouri Prairie Foundation
Keynote Address: Guardians of Flyover Country

Soapstone prairie natural area field trip. Credit: Ben Larson.

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