

3rd Great Plains Fire Summit and Patch Burn Grazing Annual Meeting

August 23-25 2022
North Platte, NE

Mission: Connecting the Great Plains fire community

Vision: Bring together those who use, regulate, respond, and live with wildland fire in the Great Plains to share knowledge, build partnerships, and improve communication.

Host: Nebraska Prescribed Fire Council
Brian Teeter, Chair

Recorded sessions will be available on the Great Plains Fire Science website following the Summit

<https://gpfirescience.org/>

Cover Photo: John Weir

Conference Booklet editors: Carol Baldwin and Lori Bammerlin.

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Prescribed Fire Planning of Nebraska
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Sandhills Task Force

Friend of Fire- \$250

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Conference Schedule

Tuesday, August 23

Pre-Conference Collaborator Meetings

<i>Time</i>	<i>Event</i>	<i>Presenter</i>	<i>Location</i>
9:00 am	Great Plains Fire Science Exchange Board Meeting		Snake River
9:00 am	Nebraska Prescribed Fire Council Meeting		Calamus River
9:00 am	Exhibitor SetUp		North Platte River
11:00 am	Registration and Networking Break with Sponsors and Exhibitors		North Platte River
12:00 pm	Lunch (on your own)		

Great Plains Fire Summit

1:00 pm	Welcome and Opening Remarks	Scott Stout	South Platte River
1:10 pm	Prescribed Burn Association Updates		South Platte River
2:00 pm	Fire in the Last Grassland Regions of North America	Dirac Twidwell	South Platte River
2:45 pm	Networking Break with Sponsors and Exhibitors		North Platte River
3:00 pm	The Impact of Prescribed Burn Associations	John Weir	South Platte River
3:45 pm	Analysis of the Fall 2021-Spring 2022 Nebraska Fire Season	Shawn Jacobs, Daren Snively	South Platte River
5:00 pm	Networking Break with Sponsors and Exhibitors		North Platte River
6:00 pm	Banquet (provided)		North Platte River
7:00 pm	Do invasive plants affect diversity and livestock performance in heterogeneous grassland? The effect of sericea lespedeza (<i>Lespedeza cuneata</i>) invasion and mitigation on the tallgrass prairie	Sam Fuhlendorf	North Platte River
8:00 pm	Evening Session Poster Session Awards: Lead Igniter, Great Plains Fire Communicator, Photo Contest, Art Contest Auction Fundraiser		North Platte River
9:00 pm	Evening Session Ends		

Wednesday, August 24

<i>Time</i>	<i>Event</i>		<i>Location</i>
8:00 am	Registration and Networking Break with Sponsors and Exhibitors		North Platte River
8:30 am	Welcome Day 2 and Updates	Brian Teeter	South Platte River
8:35 am	A Rancher's Journey to Prescribed Fire	Jim Jenkins	South Platte River
9:15 am	Fighting Fire With Fire: Coexisting with Fire in the Great Plains	Victoria Donovan	South Platte River
10:00am	Networking Break with Sponsors and Exhibitors		North Platte River
10:30 am	Great Plains NRCS Prescribed Fire Panel Discussion	Chuck Stanely, moderator	South Platte River
11:15 am	A Future with Fire	Brian Teeter	South Platte River
11:40 am	Loess Canyons Biologically Unique Landscape Tour Primer	Andy Moore	South Platte River
12:00 pm	Lunch (provided)		North Platte River
1:00 pm	Concurrent Sessions- see next page for details		
2:50 pm	Registration and Networking Break with Sponsors and Exhibitors		North Platte River
3:40 pm	Concurrent Sessions- see next page for details		
5:30 pm	Travel to D&N Event Center 501 E Walker Road, North Platte, NE		
6:00 pm	Equipment Demonstration and Social		D&N Event Center
7:00 pm	Supper (provided)		D&N Event Center
8:00 pm	Entertainment and Networking (games)		D&N Event Center
10:00 pm	Travel to hotel		

Thursday, August 25

9:00 am -	Loess Canyons Biologically Unique Landscape Field Trip
2:00 pm	Lunch provided

Concurrent Sessions – Oral Presentation Schedule – Wednesday, August 24

10 minutes are provided at the end of each presentation for transition

Room	Snake River	Calamus River	Dismal River	Niobrara River
Session	Patch Burn Grazing	PBA Producer Lessons Learned	Regulations and Policy/ Ecology	Skills Development/ Partners
1:00 pm	1. Introduction to Patch Burn Grazing - Sam Fublendorf	8. Development of Prescribed Burn Associations - Rob van Lieshout, Kyle Schumacher	14. Legal reviews of prescribed burning regulations - Morgan Treadwell, Carol Baldwin	21. Burn plan writing workshop - Doug Whisenbunt
1:30 pm	2. Creating a shifting mosaic without relying on fire - Chris Helzer	9. Prescribed fire lessons learned - Ed Hubbs, Tell Deatrich	15. Wildland fire and smoke management - Gina Grier	
2:00 pm	3. Patch-burn grazing in southwestern North Dakota: Assessing above and below ground ecosystems responses - Jonathan Spiess	10. Prescribed burning communication kit - Morgan Treadwell, Mike Watson	16. Effects of prescribed burning on butterfly populations in Coastal South Texas - Rebecca Zerlin	22. Indian Nations Conservation Alliance (INCA) - Delane Atcitty
2:30 pm	4. Pyric herbivory effects on rangeland forage quality and avoided grazable areas - Katherine Haile		17. Forage or fuel? How climate shapes long-term fire-herbivore interactions in Great Plains grasslands - John Wendte	23. Prescribed burning across boundaries: lessons learned - Tedd Teabon, Julie Baine
3:00 pm	Networking Break with Sponsors and Exhibitors			
Session	Patch Burn Grazing	PBA Producer Lessons Learned	Ecology	Partners/ Methods
3:40 pm	5. Multi-species pyric herbivory impacts on woody plant encroachment - Alex Barnes	11. Prescribed fire hurdles: Dealing with naysayers in land management - Dinyar Minocher	18. Addressing eastern redcedar in the Nebraska Sandhills - Ashley Oblander, Amanda Hefner	24. Prescribed fire programs and resources from Texas - Thomas Janke
4:10 pm	6. Patch burn grazing in below rainfall years - Morgan Treadwell	12. Using prescribed fires to mitigate wildfires - Bill Hiatt	19. Exploring effective detection of prickly pear cactus (<i>Opuntia engelmannii</i>) from airborne imagery before and after prescribed fires in the Edwards Plateau - Xavier Jaime	25. Compressed air foam for prescribed fire - Jeremy Rutherford
4:40 pm	7. A long term study of the impacts of patch-burn grazing with cattle (PBGC) as a prairie management tool on plant community response and vegetation structure response metrics in Missouri: Update on the first 5 years - Tom Thompson	13. Prescribed Fire Needs: Group Discussion - Scott Stout, moderator; - Nebraska Prescribed Fire Council	20. Safe burning of brush piles: Roundable Discussion: - TBD	26. Effects of fire on barbed wire and steel posts - John Weir

Oral Presentations

Patch Burn Grazing Meeting

1. Introduction to patch burn grazing

Sam Fuhlendorf, Oklahoma State University | sam.fuhlendorf@okstate.edu

2. Creating a shifting mosaic without relying on fire

Chris Helzer, The Nature Conservancy | chelzer@tnc.org

Patch-burn grazing is a terrific management approach but isn't a good fit for all situations. 'Open gate' rotational grazing creates very similar habitat heterogeneity conditions to PBG without relying on annual burning. It builds fuel and facilitates the use of fire but doesn't depend upon it. In addition, the open gate approach provides complete rest (exclusion of grazing animals) during recovery periods, preventing chronic of favored plant species in smaller pastures. Look, it's a weird approach, but no weirder than patch-burn grazing.

3. Patch-burn grazing in southwestern North Dakota: Assessing above and below ground ecosystem responses

Jonathan Spiess, Chadron State College | jspiess@csc.edu

Across most of the northern US Great Plains, introduced cool season grasses have altered the livestock production potential and structural composition of remaining rangelands. Alternative management strategies are needed to find balance between the production and conservation roles these rangelands are tasked with. We looked at the efficacy of patch-burn grazing in southwestern North Dakota at the Hettinger Research Extension Center with an emphasis on forage nutritive value, grazer selection, livestock weight gains, vegetation structure, plant community composition, soil nutrient pools, and the soil microbial community. We collected data over 4 grazing summer grazing seasons (2017-2020) on patch-burn grazing pastures stocked with either sheep or cow-calf pairs. Structural heterogeneity increased over time as we progressed through the first burn cycle. Although structurally similar, sheep pastures had fewer forbs and legumes than cattle pastures. Sheep and cattle both preferred recently burned patches that offering forage with higher protein and lower fiber content than what other patches offered. We found neutral and positive responses across measured nutrient pools and with the microbial community indicating these rangeland soils are resistant to patch-burn grazing. Together, these data illustrate how patch-burn grazing can achieve desirable aboveground results from both the livestock production and biodiversity conservation perspectives without sacrificing soil health.

4. Pyric herbivory effects on rangeland forage quality and avoided grazable areas

Katherine Haile, Laura Goodman, Sam Fuhlendorf, John Weir, and Bryan Murray, Oklahoma State University | katherine.haile@okstate.edu

Pyric herbivory is grazing behavior driven by palatable regrowth following fire. Patch burn grazing managers apply pyric herbivory by burning portions of a pasture and allowing cattle access to unburned and freshly burned areas simultaneously. Other studies have shown that cattle select for burn patches and freshly burned areas have higher nutritional quality. In this project based in the mixed grass prairie of Oklahoma, we strategically burned areas that cattle avoided to modify their behavior and redistribute grazing pressure in a pasture. We also evaluated the effects of patch burn grazing on vegetation composition and forage quality and minerals content. Five cows, individually equipped with a GPS collar, were placed in each of the three study pastures during the summer of 2020 and 2021. At the end of the first field season, the collars were removed and the cattle distribution was analyzed using a Hot Spot analysis to determine avoided areas. Two patches (high and low fuel load) were burned in the spring and the summer within each pasture in 2021. Cows were released in the pastures after the dormant season burn. The vegetation composition, nutritional components, and mineral contents were sampled every two months following fire until the end of the growing season. Cows were successfully drawn to previously avoided areas using patch burning. Results show that cows changed their use of previously avoided with an average of 83% of the area within burn patches increasing in use between post-burn collar deployment and growing season burns and 60% increases in use in burn patches after the growing season burns through the end of the summer. Nearly all of the forage nutritional components measured were higher in the burned patches compared to unburned areas during the same sampling session until approximately six months after fire. Grass and forb cover and total biomass was also statistically similar to unburned areas six months post-fire. Pyric herbivory is a useful tool in managing livestock distribution promoting rest or focal grazing depending on the objectives.

5. Multi-species pyric herbivory impacts on woody plant encroachment

Alex Barnes, Laura Goodman, Sam Fuhlendorf, Oklahoma State University | alexander.barnes@okstate.edu

Woody vegetation has expanded into grassland and savanna ecosystems worldwide through a process called woody plant encroachment (WPE). WPE is exacerbated by changes in climate, disturbance, overgrazing, and introduction of invasive species. The Central Great Plains has documented WPE over 150 years and has noted an alarming decline of native plant and animal biodiversity associated with encroachment. Grass biomass, density, understory, and cover decline as woody plants encroach into grasslands which can reach a threshold that makes management impossible. Management techniques for WPE within the Central Great Plains include herbicide applications, grazing and/or mechanical removal, and fire which all have varied success. However, the coupling of different types of herbivory (i.e. grazers vs browsers) has been suggested to reduce woody plant encroachment due to their different dietary selections. Our study used a combination of fire and grazing—pyric herbivory— by single and multi-species to manage for woody plant encroachment. We built exclosures (n=432) to examine the effects of single and multi-species pyric herbivory (outside exclosure) in conjunction with no herbivory (inside exclosure). We also attached GPS collars to cattle (n=18) and goats (n=9) to examine how time since fire influenced patch selection. Single and multi-species pyric herbivory declined woody plant cover and increased grass cover across all pastures compared to no herbivory. Cattle preferred patches that were recently burned (0-5 months time since fire) and goats preferred patches between 6-17 months time since fire. These results suggest that pyric herbivory has the ability to decline the rate of woody plant encroachment while increasing grass production, compared to no herbivory. Single and multi-species pyric herbivory has the potential to be utilized within the Central Great Plains as a plausible management technique for WPE.

6. Patch burn grazing in below rainfall years

Morgan Treadwell | morgan.treadwell@ag.tamu.edu

The 2021-2022 season hit the Southern Great Plains, particularly, West and Central Texas hard. Burn forecasts were few and far between due to excessive spring winds, and spring greenup never came. Despite these disastrous growing season conditions, prescribed fire practitioners continued to burn adopting a spot treatment mentality. As we watched Prescribed Burn Association members safely execute burns, we developed a renewed appreciation for prescribed fire and a West Texas definition to patch burning defined by drought and fuel. West Texas ranchers know that every prescribed fire they put off, is a fire that is never implemented. Adaptive management in a patch burn grazing approach began to develop and peer-to-peer learning was maximized as landowners witnessed burning that was not traditional West Texas burning. 2021-2022 was not a successful year for ranchers, but it was a tremendous year to learn, adapt, and implement a different kind of fire that kept West Texas, hopefully, ahead of the brush.

7. A long-term study of the impacts of patch-burn grazing with cattle (PBGC) as a prairie management tool on plant community response and vegetation structure response metrics in Missouri: Update on the first 5 years

Tom Thompson, Missouri Department of Conservation | stom.thompson@mdc.mo.gov

Beginning in 2001 the Missouri Department of Conservation (MDC) has utilized patch-burn grazing with cattle (PBGC) as a prairie management tool. Because of concerns voiced by different conservation organizations and stakeholders on the potential impacts of PBGC to remnant prairie plant communities a long-term study was designed and implemented to assess, within an adaptive management framework, what the impacts are of PBGC to the plant community composition and plant species populations and vegetation structure at five MDC managed prairies. The plant community response (PCR) study is primarily looking at plant community metrics (e.g., diversity, mean C) and specific plant species populations (occupancy/relative frequency), and the vegetation structure response (VSR) study is primarily looking at vegetation structure metrics (e.g., visual obstruction, litter depth, percent cover bare ground) and GPS-collared cattle locations. Additionally, as part of this adaptive management study, a priori decision triggers were established for the different plant community and vegetation structure response metrics by an MDC team composed of relevant managers, natural history biologists, scientists, and supervisors. Data were summarized, analyzed, and evaluated based on these decision triggers. Decision triggers were based on PBGC team experience and opinion, and were framed over the assessment period to track trends or major shifts in metric responses. These decision triggers define levels in the status of these monitored biological metrics that indicate when to undertake a management action to meet a specific objective or to avoid an undesirable change in the community. Initial results will be discussed for the first 5-year period.

Both studies provide evidence, as well as opportunities, to adapt PBGC to meet management objectives and to adapt and improve monitoring and assessments (i.e., decision triggers) to help inform evidenced-based management decisions on remnant tallgrass prairie.

Concurrent Sessions

8. Development of prescribed burn associations

Rob van Lieshout, Pheasants Forever/Quail Forever; Kyle Schumacher, Northern Prairies Land Trust | rvanlieshout@pheasantsforever.org

9. Prescribed fire lessons learned

Ed Hubbs, Tell Deatrich, Spring Creek Audubon | ed.hubbs@audubon.org

An open discussion about lessons learned while preparing for and conducting prescribed burns. Audience participation is encouraged.

10. Prescribed Burning Communication Kit

Morgan Treadwell, Texas A&M University; Mike Watson, Burnet-Lampasas Prescribed Burn Association | morgan.treadwell@ag.tamu.edu

The development of the Prescribed Burning Communications Kit was a collaborative work involving non-profits, state and federal agencies. Above all, this publication embodied the land grant mission of delivering the science to the people by enhancing federally funded research to serve landowners, Prescribed Burn Associations, and local officials. The Prescribed Burning Communication Kit provides resources to facilitate discussion and interactions within and between those who conduct prescribed burning and local communities. Learn how this collaborative project became a free and reliable product that is a complete A-Z resource for prescribed fire practitioners and officials as well as fostering a prescribed fire culture.

11. Prescribed fire hurdles: Dealing with naysayers in land management

Dinyar Minocher, Canadian Prairies Prescribed Fire Exchange | dminocher@meewasin.com

It's now widely accepted that years of suppressing natural fires have led to a loss of grassland ecosystems, a loss of suitable habitat, a decrease in plant and animal biodiversity, and a build up of fuel that leads to uncontrollable wildfires. That said, initiatives to reintroduce and build capacity for prescribed fire are often met with ardent disapproval and condemnation, even from experts within the land management and conservation world. This presentation recaps some of the trials and tribulations we've faced in the first 1.5 years of the Canadian Prairies Prescribed Fire Exchange and strategies we've engaged to deal with naysayers as we continue to move forward.

12. Using prescribed fires to mitigate wildfires

Bill Hiatt, Central Platte Natural Resource District | hiatt@cpnrd.org

Wildfires are an ever increasing threat across the Great Plains and the use of Prescribed fire to mitigate the scope, scale, and loss are an important tool needed in managing these fires. Join us as we discuss the topic and how you can integrate prescribed fire into your wildfire mitigation plans.

13. Prescribed fire needs: Group Discussion

Scott Stout, Prescribed Fire Planning of Nebraska | stout@curtis-ne.com

A guided discussion about prescribed fire needs across the state and throughout the Great Plains. From new laws and regulations, programs, equipment, and education and outreach.

14. Legal reviews of prescribed burning regulations

Morgan Treadwell, Texas A&M University; Carol Baldwin, Great Plains Fire Science Exchange | carolbaldwin@ksu.edu

State prescribed burn regulations vary across the Great Plains. Attorneys and prescribed burners are often unfamiliar with the regulations and uncertain about the risk of prescribed burning. Legal briefs summarizing regulations were prepared for eight Great Plains states to assist attorneys in advising their clients and to help prescribed burners more accurately assess the risk of prescribed burning. Key legal precedents were provided to indicate how the laws are likely to be interpreted in court.

15. Wildland fire and smoke

Gina Grier, EPA Region 7 | grier.gina@epa.gov

For over a decade, EPA Region 7 has been working with stakeholders in the Kansas Flint Hills to reduce smoke emissions from prescribed fires on their native wildland prairies. While we recognize that fire is part of a natural renewal process and essential for sustaining the tallgrass prairies, millions of acres are traditionally burned in a compressed springtime period, potentially sending unhealthy levels of smoke emissions into downwind communities.

EPA Region 7 continues to focus on outreach efforts encouraging landowners to spread out the timing of the prescribed fires to reduce air quality impacts.

As more research focuses on ecosystem diversity, sustainability, and invasive species control, EPA's Office of Research & Development, have gathered measurements to analyze prescribed fire smoke emission to better understand the difference between springtime and late summer burns.

16. Effects of prescribed burning on butterfly populations in Coastal South Texas

Rebecca Zerlin, Sandra Rideout-Hanzak, David Wester, Richard Patrock, Tyler Campbell, Texas A&M University, Kingsville; Landon Schofield, East Foundation | rebecca.zerlin@students.tamuk.edu

Approximately 76% of flowering plants rely on insects for pollination, making insect pollinators, such as butterflies or bees, vital to any ecosystem. With this knowledge, land managers should look to improve pollinator habitat in their management areas with methods such as prescribed burning. Our objective is to determine effects of varying prescribed burn intervals and seasons on butterfly populations in coastal South Texas. Plots ranging from 200 to 485 ha (500 to 1200 ac) are treated with either: summer or winter long return intervals, summer or winter short return intervals, or no-burning (control). These results will help land managers determine optimal burn season and return interval for maximizing butterfly populations.

17. Forage or fuel? How climate shapes long-term fire-herbivore interactions in Great Plains grasslands

John Wendt, Montana State University | johnafwendt@gmail.com

Fire, herbivory, and drought have influenced the evolution and distribution of North American grasslands for millions of years, yet our understanding of how fire-herbivore-drought interactions influence grassland ecosystems at millennial time scales is limited by the lack of information on changes in the distribution and abundance of large herbivore populations in North America. We analyzed several thousand dated bison observations from paleontological and archaeological records to develop a continuous record of millennial-scale bison abundance for the last 20 thousand years. We use this new bison database to evaluate the following questions: 1) How do fire and herbivores respond to changing moisture availability in Great Plains grasslands? 2) How do fire-herbivore-drought-interaction influence vegetation and the distribution of grassland ecosystems? To characterize changes in Great Plains paleoenvironments throughout the Holocene, bison abundance reconstructions were integrated into a regional multi-proxy analysis including indicators of fire activity, drought, vegetation composition, erosion, and human activity. Our results indicate bison populations and biomass burning increased as moisture availability increased in the Late Holocene (ca. 4-0 kcal yr BP) following widespread mid-Holocene warming and aridity (ca. 8-4 kcal yr BP). Despite elevated burning and herbivore pressure during the late Holocene, the distribution of grassland ecosystems remained extensive during the late Holocene and grassland vegetation generally recovered rapidly from severe late-Holocene droughts.

18. Addressing eastern redcedar in the Nebraska Sandhills

Ashley Oblander, Amanda Hefner, The Nature Conservancy | ashley.oblander@tnc.org

Nebraska is losing close to 38,000 acres a year to Eastern Redcedar encroachment. With the Nebraska Sandhills ecosystem being recognized as one of the most intact grasslands in the world, that encroachment threatens the health of the rangelands, as well as the livelihoods of those who call the Sandhills home. Come listen and learn about the collaborative effort that resulted in a trained prescribed burn team providing burn plan training, burn unit preparation support, and day-of-burn assistance to landowners throughout the Sandhills.”

19. Exploring effective detection of prickly pear cactus (*Opuntia engelmannii*) from airborne imagery before and after prescribed fires in the Edwards Plateau

Xavier Jaime, Texas A&M University | x_jaime_19@tamu.edu

Prickly pear cactus (*Opuntia engelmannii*) encroachment has significantly increased on rangelands in Texas and other semi-arid areas over the past century. However, mapping the extent of encroachment is lacking. Remote sensing analyses using multi- and hyperspectral imagery have been used successfully in previous studies to detect species such as *Prosopis glandulosa* through supervised classification with object-based segmentation. Several methods exist for high-resolution image classification, including machine learning (ML) techniques such as Random Forest (RF) and Support Vector Machines (SVM). In this study, we explore the performance of ML classification for accurately mapping prickly pear cactus within heterogeneous savannas from multispectral airborne imagery. Airborne multispectral (0.22-m resolution) imagery was acquired before and after patch burning on a research ranch in the Edwards Plateau of Texas for use in ML classification. For training and testing the ML classification, prickly pear cover data were collected from 188 2-m radius plots within a 171-acre burn unit, both pre-fire and post-fire. After classification, we evaluated RF and SVM performance for classifying prickly pear for both pre-, and post-fire imagery. An analysis of pre-, and post-fire plot data indicated that prickly pear cover declined significantly after the burn (p-value = 0.016), while significant reductions in herbaceous canopy structure within (p-value = 0.02). Results of the ML analyses showed that the SVM model slightly outperformed the RF model by scoring a higher Kappa (0.79 vs. 0.77), Accuracy (0.83 vs. 0.81), and a higher prickly pear detection rate in prefire (0.38 vs. 0.19) and postfire (0.68 vs. 0.42) imagery. The higher detection rate in the post-fire imagery is likely due to the fire reducing herbaceous vegetation and exposing the prickly pear canopy, thus improving ML predictions. The overall (%) change in classified prickly pear cover in the burn unit showed a 10.48% decline after the burn, with an increase of 6.42% of cover in unburned areas within the burn unit. Six months after the burn, % prickly pear cover continued to decline by 10.59% within the burn areas while increasing by 7.03% in unburned areas. Given the lower-than-expected detection of prickly pear, future work will focus on the use of adding spectral index bands (e.g., NBR), Segment Mean Shift, and Spectral Hourglass methods to improve classification performance.

20. Roundtable Discussion: Safe burning of brush piles

Moderator to be determined

21. Burn plan writing workshop

Doug Whisenhunt, USDA Natural Resources Conservation Service | doug.whisenhunt@usda.gov

22. Indian Nations Conservation Alliance

Delane Atcitty, Indian Nations Conservation Alliance | delane.atcitty@inca-tcd.org

The Indian Nations Conservation Alliance (INCA) is a nonprofit 501(C)3 organization established to promote community-based and locally-led holistic conservation activities to protect Mother Earth for future generations by establishing and supporting Tribal Conservation Districts. INCA believes that conservation supports tribal solidarity and provides resiliency to tribal nations to protect and shield their culture, sovereignty and lands. Together we can foster Native Agriculture by helping tribal farmers and ranchers to care for and strengthen the circle of life. INCA assists Tribal Conservation Districts, Tribal Nations and holistic land stewards to instill traditional knowledge, while protecting and restoring the Circle of Life to heal Mother Earth.

23. Prescribed burning across boundaries: lessons learned

Tedd Teahon, Julie Baine, US Forest Service, Nebraska | tedd.teahon@usda.gov

24. Prescribed fire programs and resources from Texas

Thomas Janke, Pheasants Forever/Quail Forever | tjanke@pheasantsforever.org

Throughout Texas, there is considerable effort among private landowners and conservation professionals to manage our natural resources, on both private and public lands, effectively and efficiently. Of Aldo Leopold's 5 habitat management tools – ax, cow, plow, fire, and gun – fire is arguably the most debated tool due to its complexities in understanding, implementation, and ecological value. Furthermore, various levels of prescribed fire acceptance, financial support, and utilization occur across Texas throughout individual properties, landowner cooperatives, local governments, state agencies/organizations, and federal agencies/organizations. So, when it comes to being a private landowner or conservation professional interested in implementing prescribed fire as a habitat management tool, it can become very daunting to try and figure out if and when prescribed fire may be the most beneficial tool to accomplish the management goals at hand, and what avenue/organization is most suited to best help them through the process. This presentation will showcase the best available information on whom is involved within the professional prescribed fire community in Texas, and how they are involved – whether that be at the research, planning, implementation, or legislative levels. We will also discuss various opportunities of financial and/or resource support from companies, organizations, or agencies available to landowners and/or other organizations interested in utilizing prescribed fire. Ultimately, by being able to best understand the resources landowners and organizations have available to them to safely and successfully accomplish their land management goals using prescribed fire, we will collectively be able to more effectively and efficiently manage our natural resources!

25. Effects of fire on barbed wire and steel posts

John Weir | john.weir@okstate.edu

The impact of prescribed fire and wildfire on 12.5 gauge barbed-wire and steel T-posts has been a topic of concern for years. Research shows that there is no impact on barbed-wire and steel T-posts from prescribed fire or wildfire. The myth of fire weakening and damaging these important range improvements will be discussed.

26. Compressed air foam for prescribed fire

Jeremy Rutherford, Comstock Decon | jeremy@comstockdecon.com

Posters

P1. The Prairie Project: Learning about woody brush encroachment outside the classroom, College Station, USA

Erika Sullivan, Morgan Treadwell, Maria Macik, Texas A&M University | erikans2010@hotmail.com

Over the past hundred years in the Southwestern Great Plains a takeover of woody plants has been occurring. This woody plant encroachment has been disrupting the hydrology, biodiversity, production, and overall nutrient cycling of rangelands. However, new tools and techniques such as prescribed burning, patch-burn grazing, and pyric herbivory have been developed to help remove and prevent these woody invaders from spreading. In addition, new technology applications such as the Rangeland Analysis Platform (RAP) have been created to help assist in the managing/monitoring of America's rangelands. The Prairie Project strives to use this current knowledge on woody plant removal/monitoring and apply it into the hands-on, in-field classrooms of 4H and FFA students. A protocol has been created that will allow for students to use RAP to analyze the effects of (prescribed fire, patch-burn grazing, and multi-species grazing) on the four different plant types (grasses, forbs, shrubs, trees) found on rangelands. Students will actively participate and engage with Demonstration Ranches that have employed multi-species grazing, prescribed burning, and patch-burn grazing to manage woody brush encroachment. Students will be given full access to these ranches, including virtually, with identifiable pasture treatments relying on the RAP during the first year and in-field assessments the following year. Students will actively determine changes in percent cover of (grasses, forbs, shrubs, trees, bare ground) on pastures with history of prescribed fire, no fire, pyric herbivory, traditional rest rotations following fire, and multi-species grazing, and single-species grazing. More importantly, students will become familiar with each unique Demonstration Ranch and the philosophies of each owner/operator. This relationship will be evaluated as students progress through the Prairie Project as informed agents of change based on action research.

P2. Effects of Fire Seasonality and Frequency on the Phytochemical Properties of Shrub Species in the Edwards Plateau of Texas

Deann Burson, Morgan Treadwell, Texas A&M AgriLife Extension | deann.burson@ag.tamu.edu

An increase in environmental uncertainty has prompted the need for further studies on how plant species respond to various levels of stress. Potential implications of plant adaptation responses to fire can be used to relate science back to practical management strategies derived from research because grazing dynamics are affected by phytochemical and physical plant characteristics. Not only do antiherbivore defenses directly impact herbivory, but they also promote the survivability of the plant which can indirectly affect grazing by influencing long-term changes in vegetation density and distribution in favor of unpalatable plant species. Further, the nutrient balance of plants in relation to stress and the resulting concentration of toxins varies between carbon (phenolics, terpenes) versus nitrogen-based (alkaloid) defenses. A broader understanding of how forage species and their associated toxins and biological characteristics respond to stress can be used to the advantage of the rangeland manager by facilitating educated decision-making. If plants become less chemically defended, the opportunity may exist to capitalize on the increased herbivory of an underutilized forage species. Conversely, timing and intensity of fire could be tools used to lessen the negative impact of plants that become more chemically defended following fire. Although we cannot control all variables on the landscape that drive change, we can seek to enhance our knowledge of how individual parts respond to these drivers so we may build upon the resiliency of rangelands and alter management strategies accordingly.

The objectives of this study are to 1) determine if the season of fire (spring, summer, or winter) influences the accumulation of plant secondary metabolites in *Prosopis glandulosa* Torr. var. *torreyana* during the resprouting process, 2) to analyze the influence of disturbance (e.g., fire, frequent fire, grazing) on the concentration and composition of monoterpenes in *Juniperus pinchotii* foliage.

P3. Flint Hills burn days climatology

Jayson Prentice, Kansas Department of Health and Environment | Jayson.Prentice@ks.gov

The Flint Hills region has an extensive pyric history to maintain the Tallgrass Prairie ecosystem and encourage beneficial cattle grazing conditions. Land managers often have an extensive list of conditions required to conduct a prescribed burn that is beneficial for their land management goals, but one of the common deterrents is weather conditions. This study reviews weather data from multiple weather stations in the Flint Hills to match common conditions required for a successful prescribed burn and find the number of burn days typically available. Data will be presented by Flint Hills sub-region, month, and interpreted for trends in number of burn days available. Additional details on common wind direction, average burn window hours, and other data interpretations are also available.

P4. Effects of patch burn grazing on rangeland forage quality and avoided grazable areas

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Pyric herbivory is grazing behavior driven by palatable regrowth following fire. Patch burn grazing managers apply pyric herbivory by burning portions of a pasture and allowing cattle access to unburned and freshly burned areas simultaneously. Other studies have shown that cattle select for burn patches and freshly burned areas have higher nutritional quality. In this project based in the mixed grass prairie of Oklahoma, we strategically burned areas that cattle avoided to modify their behavior and redistribute grazing pressure in a pasture. We also evaluated the effects of patch burn grazing on vegetation composition and forage quality and minerals content. Five cows, individually equipped with a GPS collar, were placed in each of the three study pastures during the summer of 2020 and 2021. At the end of the first field season, the collars were removed and the cattle distribution was analyzed using a Hot Spot analysis to determine avoided areas. Two patches (high and low fuel load) were burned in the spring and the summer within each pasture in 2021. Cows were released in the pastures after the dormant season burn. The vegetation composition, nutritional components, and mineral contents were sampled every two months following fire until the end of the growing season. Cows were successfully drawn to previously avoided areas using patch burning. Results show that cows changed their use of previously avoided with an average of 83% of the area within burn patches increasing in use between post-burn collar deployment and growing season burns and 60% increases in use in burn patches after the growing season burns through the end of the summer. Nearly all of the forage nutritional components measured were higher in the burned patches compared to unburned areas during the same sampling session until approximately six months after fire. Grass and forb cover and total biomass was also statistically similar to unburned areas six months post-fire. Pyric herbivory is a useful tool in managing livestock distribution promoting rest or focal grazing depending on the objectives.

P5. Texas Tortoise (*Gopherus berlandieri*) response to prescribed fire in South Texas Coastal rangelands

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Prescribed fire has become an increasingly popular tool in managing vegetation conditions and can create heterogeneity in vegetation cover and structure. Some wildlife species that utilize both grassy and brushy areas may benefit from the variation in vegetation that fire produces. However, there is a lack of studies examining the effects of fire on herpetofauna. Currently, we have found no data on fire effects specific to Texas tortoises (*Gopherus berlandieri*), which is listed as state threatened in Texas. Though the Texas tortoise may be considered a rather sedentary species with short activity periods, their movement and activity may be closely linked to temperature. This study aims to assess survival and movement of these tortoises through burn events by comparing the movements of tortoises in pastures that experience summer burns, control patches that are not burned, and patches that will be burned in the winter. Additionally, temperature information was collected on the tortoises' carapaces to examine how tortoise performance is associated with the external temperatures they experience. This study may allow us to determine a season of burning that is directly less lethal to the tortoises and that indirectly supports their populations by providing variation in available vegetation cover and structure. At the end of the study, we may be able to make recommendations to landowners in south Texas on how they can manage their property in a way that also supports conservation of wildlife.

P6. Re-encroachment is not encroachment again

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Prescribed fire is increasingly used as a tool to reverse woody encroachment and restore grasslands. Yet the lifespan of these treatments are unknown and how quickly re-encroachment occurs remains a key question for fire managers. In a series of studies conducted in the Loess Canyons Experimental Landscape of central Nebraska, we determined the rate of eastern redcedar re-encroachment and examined whether the re-encroachment process occurs faster than the initial encroachment process. This work leverages more than 15 years of high intensity fires used for restoring mixed-grass prairie on private rangelands. Our results show that re-encroachment is different from the initial encroachment process. Re-encroachment occurs faster and is driven by high rates of seedling establishment in grasslands recently restored from a juniper woodland state. These results illustrate the importance of follow-up management to extend the lifespan of grassland restoration and provide a basis for developing timelines for post-fire management.

P7. Examining cattle and bison response to prescribed burning in semi-arid northern mixed prairie

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Historic patterns of fire and grazing by large ungulates, key ecosystem processes in most North American grasslands, have been altered significantly since European settlement. Persistence of biological diversity, critical to sustain complex food webs and ecosystem goods and services, is contingent on understanding and implementing those natural processes driving habitat creation in the modern context of declining habitat quality and availability. Fire, grazing, and their interaction diversify grassland structure, function, and composition at multiple scales and may increase habitats available to a greater variety of species. In this study, we confirm large ungulates are attracted to re-growing plants following prescribed fire in a semi-arid, northern mixed grassland, preferentially selecting burned sites leaving unburned areas and other landscape features relatively less utilized, creating more diverse, multiscale, spatiotemporal patterns in grassland vegetation than with grazing alone. Grazing patterns of plains bison (*Bison bison*) and domestic cattle (*Bos taurus*) were tracked via GPS collars and vegetation evaluated with imagery derived from the Sentinel-2 satellite and Unmanned Aerial Vehicles (UAV) integrated with in situ data; before and after prescribed fire, yielding very fine-grained analysis of plant and animal responses. Grazing of burned sites was compared to other available habitats by mixed condition logistic regression, segregated by topography, landscape feature, and plant community composition, productivity, and condition; and evaluated over the grazing season to determine changes in selectivity over time. Impacts to plant community characteristics were, in turn, examined by Redundancy Analysis (RDA) to ascertain the relative importance of fire, grazing, and their interaction when compared to other factors, especially annual weather patterns. The fire-grazing interaction is hypothesized to emulate an historic pattern of disturbance, and while absent in most western Canadian grasslands, may be one of the key drivers for sustaining biological diversity and critical for conservation of native prairie, wildlife, and species at risk. This research represents a unique, multiscale evaluation of beneficial management practices to provide stakeholders clear guidelines to enhance economic and environmental sustainability.

P8. Greater Prairie-Chicken vulnerability to biome scale grassland collapse

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Greater prairie-chickens (GRPC) are an iconic umbrella species in the Great Plains grasslands. Healthy populations GRPCs indicate intact, heterogenous grasslands. Grasslands are the most imperiled ecosystem in the world, currently under great threats from woody encroachment. This threat has created a biome scale woodland transition in the Great Plains referred to as a Green Glacier. The Green Glacier's front lines are currently at the state of Nebraska. This heightens the GRPC's vulnerability as this transition closes in on the last stronghold for this species. This stronghold is primarily found in the Sandhills region, the most intact grassland region in the world. Here, we will show the GRPC's population stronghold's proximity to signals of grassland biome collapse and how this has changed through time.

P9. Patch-burn grazing increased structural heterogeneity in southwestern North Dakota

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Persistent land use change throughout the North American Great Plains increases the need to maintain and improve ecosystem service delivery from remaining rangelands to meet production and conservation goals. In this study, we investigated the efficacy of patch-burn grazing to increase structural heterogeneity on semi-arid post-Conservation Reserve Program grasslands in southwestern North Dakota. We surveyed plant community composition and structural characteristics in patch-burn grazing pastures during the 2017 – 2020 summer grazing seasons. Three pastures were stocked with cow-calf pairs and three stocked with sheep. We also surveyed structural characteristics on units with conventional management (hay or idle) for active and post-CRP enrolled grasslands during summers 2018 – 2020. We tested for vegetative and structural differences between patches with varying time since fire and between grazer type on patch-burn pastures using mixed-effect models and ordination. We used variance partitioning to determine if structural contrast on patch-burn pastures increased over the study period and if structural contrast was higher on patch-burn grazing pastures relative to conventional management. Time since fire was significant for all structural characteristics with recently burned patches being different from other patches. There were no structural differences between cattle and sheep pastures, but forb and legume cover were lower in sheep pastures. Structural contrast on patch-burn pastures increased over the study and was greater than conventional management. Increased structural heterogeneity is important for supporting a broad suite of rangeland wildlife and can also stabilize forage production. This study supports the expectation that patch-burn grazing with moderate stocking rates will increase structural contrast regardless of grazer type, but practitioners should consider which suites of species that management may benefit.

P10. Community Management of Woody Encroachment Across the Great Plains

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As woody encroachment has increased across the Great Plains, perception of this problem, management practices, and social norms have changed as well. This research project will compare communities that have experienced woody encroachment and its impacts for an extended period of time to communities that are just beginning to experience woody encroachment in four states across the Great Plains. This comparison will help us understand what motivates land managers to control woody encroachment and how we might increase proactive management that targets early stages of woody encroachment.

See you in Texas for the 4th Great Plains Fire Summit 2024!

Visit our sponsor booths!

Nebraska Prescribed Fire Council

The Nebraska Prescribed Fire Council was formed by landowners for the purpose of promoting the common good and general welfare for the people in Nebraska by educating, training, and practicing safe prescribed burn techniques that reduce or eliminate invasive species and fuel load build-up in open spaces, providing fire protection and/or prevention from wild or unexpected fires in and near these open places. The council will strive to: provide an outlet for prescribed fire practitioners to exchange ideas within the state, regionally, and nationally; initiate involvement with other state's burn associations; and provide advocacy for prescribed fire practitioners including policy, legislation, and liability changes. Most importantly they will help increase knowledge of safe fire practices through research, training, and outreach.

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Nebraska Game and Parks Commission

The mission of the Nebraska Game and Parks Commission is stewardship of the state's fish, wildlife, park, and outdoor recreation resources in the best long-term interests of the people and those resources.

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Pheasants Forever

Pheasants Forever and Quail Forever are dedicated to the conservation of pheasants, quail, and other wildlife through habitat improvements, public awareness, education and land management policies and programs. Since 1986, Nebraska's 63 chapters and over 10,000 members have created and enhanced over 5.5 million acres of habitat, worked on 124,000 projects, and have spent over \$75 million on habitat and conservation education projects through innovative programs and partnerships. Since 2008, PF/QF has also helped fund and support 11 local prescribed burn associations, impacting 70,000 acres on 850 burns and providing classroom training to 3,000 people through 130 prescribed fire training workshops across the state.

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Great Plains Fire Science Exchange

The Great Plains Fire Science Exchange exists to assist land managers and the fire community to make sound decisions based on the best possible information. Through this information sharing process, we hope to strengthen collaboration within the fire community in the region in addition to having information available for policy makers. Fire is an inherent characteristic of grassland ecosystems. We humans share the Great Plains ecosystem with many fire-dependent plants and animals. Becoming "people of fire" involves acknowledging the natural landscape in which we live, with its benefits and consequences. Science can provide insight for making the complex decisions that meet the needs of both humans and the ecosystem.

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Canadian Prairies Prescribed Fire Exchange

The Canadian Prairies Prescribed Fire Exchange is an inter-agency collective driven by the urgent need to build capacity and share knowledge surrounding the use of prescribed fire as a management tool in Canadian prairie and parkland ecosystems. CPPFE provides learning and training opportunities, facilitates equipment and resource sharing, and acts as a hub for current fire science and grassland fire knowledge. We're here to help fire practitioners of all backgrounds, from landowners, to communities, to conservation groups and even experienced firefighters. Our partners include experts with many decades of experience planning, leading, and assisting with prescribed fires. Fire is an essential component of the grassland ecosystem, and more fire is needed to reverse the decline of biodiversity occurring in our prairies.

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The Prairie Project

The Prairie Project is a collaboration between research, teaching, and extension faculty from Texas A&M, Oklahoma State University, and University of Nebraska. Together with ranchers, teachers and students from Texas, Oklahoma, Kansas and Nebraska we are learning and sharing our knowledge from the most current research and management experience to tackle the problems of woody plant encroachment, more extreme climate, and increasing wildfire. Our goal is to not only maintain livestock production but increase it while simultaneously providing the vital ecosystem services the Southern Great Plains provide.

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Southern Rockies Fire Science Network

Southern Rockies Fire Science Network: Sharing fire knowledge from mesas to mountains!
SRFSN connects people with credible fire science for sound decisions in land management and planning regarding fires on public and private lands, rangelands, and impacts on our region's populated areas. We help identify and address hot topics in wildfire across Wyoming, Utah, Colorado, and forested areas of South Dakota and northwest Nebraska. Over the last ten years, we have created or supported hundreds of in-person and online events, webinars, publications, and social media used both nationally and worldwide. We also provide support or mini-grants for regional projects, events, training, and travel for anyone interested in or affected by wildfire. Follow us on @SRfirescience, and be sure to stop by our booth for more information!

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Tallgrass Prairie and Oak Savannah Fire Science Consortium

The Tallgrass Prairie and Oak Fire Science Consortium works to share information about fire ecology and management in the highly-fragmented eastern tallgrass prairie and prairie-forest border region. We foster knowledge sharing within our regional fire community as well as with neighboring regions, including the Great Plains, Lake States, and Oak Woodlands and Forests. In 2022, the consortium and partners organized the first annual Hands-On Fire Science Workshop to support the growth of fire ecology in the eastern tallgrass prairie. The workshop is intended for graduate students and early career professionals and focused on methods for quantifying fuels, the fire environment, and fire effects in tallgrass prairie, as well as providing opportunities for researchers and land managers to work side by side.

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Loess Canyons Rangeland Alliance

The Loess Canyons Rangeland Alliance (LCRA) is seeking to improve the management of valuable rangeland resources while increasing range productivity and controlling invasive species. Through education, the LCRA hopes to teach the benefits of rangeland management, enabling landowners to use their resources more efficiently. LCRA also strives to deepen landowners' commitment to environmentally sound practices, including prescribed burning, prescribed grazing and wildlife habitat management. These are the practices that LCRA believes will help protect the environment for future generations. Since 2002, we have led the effort to reclaim nearly 60 thousand acres of rangeland in Nebraska from Eastern Redcedar encroachment.

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**LOESS CANYONS
RANGELAND
ALLIANCE**

Central Platte Rangeland Alliance

The Central Platte Rangeland Alliance was founded in 2008 and covers an area from north of Gothenburg to south of Farnam, east to Elwood and west to Grady. The Central Platte Rangeland Alliance has worked to fight back the spread of the Eastern Red Cedar in Central Nebraska for nearly 2 decades. Their primary and most proven method over those years has been prescribed burning in the spring. As more people see the results, they want to use prescribed fire to control the cedar trees on their land.

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Prescription Pyro LLC

Fire, like rain and sunshine, has played an important part in our environment for millions of years. Prescription Pyro mimics the natural role of fire in our landscapes and helps to conserve the rich diversity of life on Earth.

A custom burning business. The use of prescribed fire to reclaim the land. The benefits are removing cedar trees, brome grass, weeds, overgrown vegetation, and debris piles. It is also used as a management tool for private hunting habitat and government reserve acres like CRP ground. We also remove cedars with chainsaws and do snow removal in winter. We travel the U.S. for NWCG fire training, fighting federal fires, national disasters, and working countries on a global scale to put safe fire on the ground for management tools.

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PRESCRIPTION PYRO, LLC

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The Nature Conservancy

The Nature Conservancy is a global environmental non-profit working to create a world where people and nature can thrive. Founded in the U.S. through grassroots action in 1951, The Nature Conservancy has grown to become one of the most effective and wide-reaching environmental organizations in the world. Thanks to more than a million members and the dedicated efforts of our diverse staff and over 400 scientists, we impact conservation in 72 countries and territories: 38 by direct conservation impact and 34 through partners. Our mission is to conserve the lands and waters on which all life depends. To achieve this, we must boldly address the biodiversity and climate crises over the next decade. By maximizing our ability to affect change between now and 2030, we can shape a brighter future for people and our planet.

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Nebraska Grazing Lands Coalition

Dedicated to the enhancement of grasslands, the Nebraska Grazing Lands Coalition is comprised of ranchers and private landowners all focused on creating public awareness and improvement of the grazing lands in Nebraska. The organization's top focus is to provide voluntary technical assistance and educational opportunities on grazing land management. Healthy Nebraska grazing lands translate directly into forage for livestock, habitat for wildlife, economic benefits for landowners and rural communities, and clean water for much of the Great Plains. NGLC is the state entity of the national Grazing Land Conservation Initiative — which is supported by the USDA Natural Resources Conservation Service to enhance privately owned grazing lands in the nation.

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Natural Resources Conservation Service

NRCS's natural resources conservation programs help people reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. NRCS provides funding opportunities for agricultural producers and other landowners through these programs.

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Mid-Missouri River Prescribed Burn Association

The Mid-Missouri River Prescribed Burn Association is a non-profit formed to control cedar tree infestation and improve grassland health by conducting prescribed fires. MMRPBA's efforts will focus on land in Brule, Charles Mix, Gregory and Lyman Counties in South Dakota, with the goal to conduct 2,000 acres of prescribed burning each year. Join the effort to help combat cedar tree invasion, reclaim lost grazing lands and eliminate wildfire risks along the Missouri River Corridor.

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Nebraska Association of Natural Resource Districts

The mission of Nebraska's Natural Resource Districts is to assist NRDs in a coordinated effort to accomplish collectively what may not be accomplished individually to conserve, sustain, and improve our natural resources and environment. Nebraska's NRDs operate more than 80 recreation areas. Nebraska's NRDs are involved in a wide variety of projects and programs to conserve and protect the state's natural resources. While all NRDs share these responsibilities, each district sets its own priorities and develops its own programs to best serve local needs. Districts often team with other agencies to carry out projects. Technical services and administration for many NRD programs are provided by the USDA Natural Resources Conservation Service.

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Drone Amplified

Drone Amplified manufactures an aerial ignition device called IGNIS. IGNIS is operated from a commercially available drone. and is controlled through an easy-to-use custom app that intelligently controls and monitors flights and ignitions. IGNIS carries a payload of 400 ignition spheres (sometimes called dragon eggs) that are pre-loaded with potassium permanganate. Before release, the spheres are injected with ethylene glycol (antifreeze) which starts a chemical reaction that generates fire about 30 seconds after release when the balls hit the ground. Over a hundred IGNIS systems are currently being operated in the USA, Canada, Australia and New Zealand. Operators include the US Forest Service, several US Dept of Interior agencies, many state forestry departments and several private contractors.

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Prescribed Fire Planning of Nebraska

Prescribed Fire Planning of Nebraska, LLC is a small privately owned business that provides the service of writing burn plans for all persons wanting to utilize prescribed fire as a management tool. This business specializes in writing burn plans that meet all EQIP and Nebraska state standards. Prescribed Fire Planning's goal is to assist all persons in conducting prescribed fire with a safe and effective burn plan that they can utilize on their operations and meet all expectations that have been set.

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Sandhills Task Force

The Sandhills Task Force is a non-profit organization consisting of a 16-member board of Sandhill ranchers and conservation agencies. The organization's goal is to enhance sandhill wetland-grassland ecosystem in a way that sustains profitable private ranching, wildlife and vegetative diversity, This is accomplished using a variety of approaches including promoting research, education, technical assistance, and on-the-ground conservation practices. The policy of the STF is to remain non-political in affecting change within the area. Its interest, rather, is to help ranchers, land managers, and governing bodies make informed decisions regarding the Sandhills resources. The organization serves 20,000 square-mile sandhills area.

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