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# Patch Burning: Integrating Fire and Grazing to Promote Heterogeneity

John R. Weir
*Oklahoma State University*

Samuel D. Fuhlendorf
*Oklahoma State University*, sam.fuhlendorf@okstate.edu

David M. Engle
*Oklahoma State University*, david.engle@okstate.edu

Terrence G. Bidwell
*Oklahoma State University*

D. Chad Cummings
*Dow AgroSciences*

***See next page for additional authors***

**Authors**
John R. Weir, Samuel D. Fuhlendorf, David M. Engle, Terrence G. Bidwell, D. Chad Cummings, Dwayne Elmore, Ryan F. Limb, Brady W. Allred, J. Derek Scasta, and Stephen L. Winter

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Department of Natural Resource Ecology and Management
Oklahoma Cooperative Extension Service
Oklahoma State University

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**John R. Weir**
**Research Associate**
**Natural Resource Ecology and Management**

**Samuel D. Fuhlendorf**
**Sarkeys Distinguished Professor**
**Natural Resource Ecology and Management**

**David M. Engle**
**Regents Professor**
**Natural Resource Ecology and Management**

**Terrence G. Bidwell**
**Professor and Extension Specialist**
**Natural Resource Ecology and Management**

**D. Chad Cummings**
**Field Scientist**
**Dow AgroSciences**

**Dwayne Elmore**
**Associate Professor and Extension Specialist**
**Natural Resource Ecology and Management**

**Ryan F. Limb**
**Assistant Professor**
**School of Natural Resources**
**North Dakota State University**

**Brady W. Allred**
**Assistant Professor**
**Department of Forest Management, University of Montana**

**J. Derek Scasta**
**Graduate Research Associate**
**Natural Resource Ecology and Management**

**Stephen L. Winter**
**Wildlife Biologist**
**U.S. Fish and Wildlife Service Service**

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## Historic Images of Heterogeneity

Heterogeneity refers to the differences in habitats across the landscape, and it is required for diverse plant and wildlife communities. Some heterogeneity is inherent, caused by differences in soils, while most heterogeneity is disturbance driven. Climate, fire, and grazing are the main three disturbance factors that have historically shaped the landscape. All three are still very important to the continued diversity and health of the plants and animals associated with our prairies, shrublands, and forestlands across the Great Plains. While we cannot control the climate, we can manage grazing by stocking rate, season of use, and kind and type of animal. Fire can also be managed by frequency, season, and weather conditions. To keep biodiversity intact, these disturbances should be considered collectively, rather than independent of each other.

Fire was so important in the maintenance of grasslands and savannas that one of the Native American tribes from the northern plains used the same word for both prairie and fire (Figure 1). Numerous historical accounts of frequent fires across the entire Great Plains can be found to substantiate its importance to the plants and animals of the region. These areas burned every three to seven years, with some areas often burning twice in the same year. In the autumn of 1832, Washington Irving described the land in Indian Territory as: "The grass is at times green and short and at other times tall and white…nothing but bare prairie, which becomes confused in the distance with the smoke of burning grass." This describes a landscape of burned and grazed (green and short) areas (we call burned patches), along with areas of ungrazed and unburned grass (tall and white) (we call unburned patches)–a verbal picture of a heterogeneous landscape (Figure 2).

Fire alone cannot maintain the heterogeneity necessary for rangeland health, but fire with grazing is important in the creation and maintenance of the diverse habitats needed to support the numerous plants and animals across the land. Grazing distribution and habitat selection by feeding animals is determined by decisions made at multiple levels:

Landscapes (i.e. Tallgrass Praire) → Communities (i.e. upland site) → Patch (i.e. burned area) → Feeding Station (i.e. site within burned area) → Plant (i.e. Indiangrass) → Plant Part (i.e. leaf) (Figure 3).

From historical fire and grazing patterns we know that animals preferentially select burned areas and graze them heavily. When another area was burned, they shift their utilization to this new patch. This allows the previously burned and closely grazed patch to rest until

**Figure 1. Native Americans were well adapted to the use of fire. Extensive areas across the Great Plains burned every three to seven years, with some areas burning twice in the same year. Photo by Stephen Winter.**

**Figure 2. In the autumn of 1832, Washington Irving described the land in "Indian Territory" as: "The grass is at times green and short and at other times tall and white…nothing but bare prairie, which becomes confused in the distance with the smoke of burning grass." This is a verbal picture of a heterogeneous landscape. Photo by Stephen Winter.**

**Figure 3. Grazing distribution and habitat selection by feeding animals is determined by decisions made at multiple levels: Landscapes (i.e. Tallgrass Praire) → Communities (i.e. upland site) → Patch (i.e. burned area) → Feeding Station (i.e. site within burned area) → Plant (i.e. Indiangrass) → Plant Part (i.e. leaf). From historical fire and grazing patterns we know that animals preferentially select burned areas and graze them heavily. Photo by Samuel D. Fuhlendorf.**

adequate fuel had grown back, which allowed the next fire event. This fire-grazing interaction would create a shifting mosaic over the entire landscape that was critical to the conservation of biodiversity.

Most grazing management promotes uniform distribution and utilization, which creates homogenization of the vegetation. These practices include uniform distribution of focal attractants (i.e. water, salt, mineral), prescribed fires that burn the entire management unit, and application of fertilizers and herbicides. The most effective homogenization practice is grazing systems, especially rotational grazing. Rotational grazing reduces diversity of plant communities and wildlife species, and despite popular contrary claims, rotational grazing also reduces livestock production and net return per acre by forcing livestock to graze equally across all areas of a pasture.

Traditional approaches to grazing overlook the potential benefits of coupling fire and grazing. Most often, grazing is the only practice used and often to the point of over utilization. Conversely, if a land manager uses fire, it is normally implemented with deferment of grazing before and after the fire. Rarely are these two ecosystem drivers used together as they occurred historically on native prairies.

## Diversity Across the Landscape

Many grassland wildlife species require specific habitats to thrive and management recommendations often focus on single species. An example of the complexity associated with managing for multiple species is evident from a study of grassland bird habitat needed by the Horned Lark (*Eremophila alpestris*) and Grasshopper Sparrow (*Ammodramus savannarum*) across seven grasslands in five states (Figure 4). These two grassland birds require contrasting habitats, so at first glance a manager would be challenged to mange for them collectively. Yet, these species have coexisted for thousands of years suggesting the importance of heterogeneity (Figure 5). With diversity across the landscape all species have suitable habitat at some place in the landscape, even though not all space is suitable at a given point in time. This allows all species to persist over the entire landscape.

Some wildlife species require a diversity of habitats in different seasons and for different life stages. Managing for uniform distribution of livestock deprives these habitat specialists of the diverse requirements that they need to thrive. For example, Lesser Prairie-Chickens (*Tympanuchus pallidicinctus*), which have declined in range and popula-

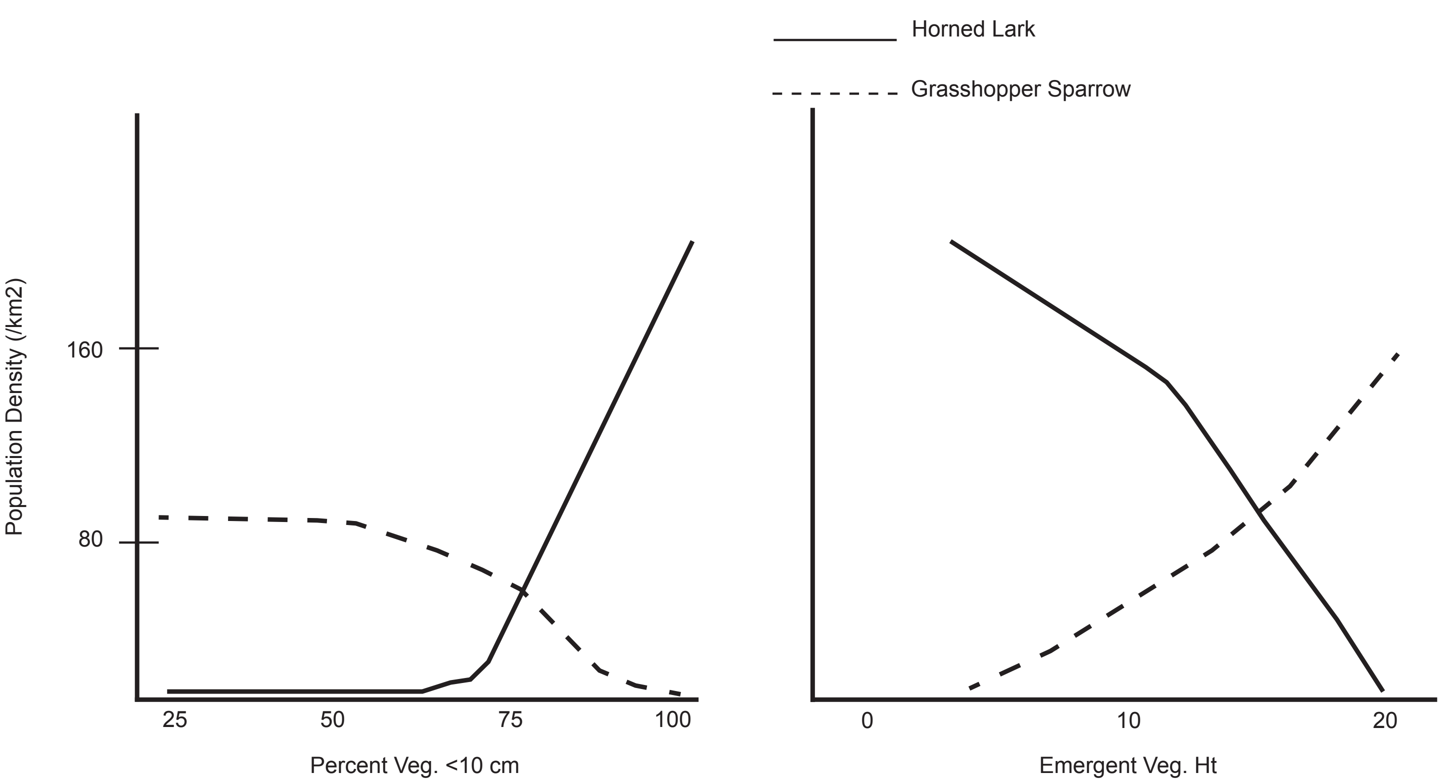


**Figure 4. Role of habitat structure plays for two prairie bird species on seven Great Plains grasslands (from Weins 1973). These two grassland birds require contrasting habitats, so managing for Horned Lark manages against Grasshopper Sparrow and vice versa.**

**Figure 5. Most existing grazing management promotes uniform livestock distribution and forage utilization (right), which reduces diversity of native plant communities and wildlife species. A heterogeneous landscape (left) is critical to the conservation of biodiversity. Photos by Samuel D. Fuhlendorf.**

tion by greater than 90% over the last several decades, require diverse habitats (Table 1). Plant communities that are optimum for leking or foraging may not be optimum for nesting success of Lesser Prairie-Chickens. Therefore, if all rangeland is managed to produce uniformity, this species, along with many others will not be present.

## Biodiversity and the Fire-grazing Interaction

Biodiversity is a measure of the relative diversity among organisms present in different ecosystems. To maintain biodiversity in the Great Plains we need to avoid the traditional management for the middle, uniform moderate disturbance (homogeneity), and strive to manage for the entire spectrum of disturbance (heterogeneity) (Figure 6). This means developing a management practice that uses the historic fire-grazing model to manage these ecosystems.

The historical fire-grazing interaction that occurred throughout the Great Plains was a shifting mosaic of disturbances across the landscape that included areas that were burned, grazed, burned and grazed, along with regions that were not disturbed. An area would burn and as it greened-up herbivores of all kinds would concentrate on it (Figure 7). This burned area would become heavily utilized which caused other areas to receive very little grazing pressure. Then at some time during the year another area would burn causing these animals to focus on the most recently burned area. This would allow the previously heavily utilized area to recover for a certain period of time before it would be burned and grazed again. This fire-grazing interaction would repeat itself all across the landscape with timing being determined by climate and reignition. This random disturbance pattern created a messy landscape that allowed all plant and animal species to exist simultaneously.

## Pyric-herbivory

There is some thought that keystone native herbivores, such as the American bison (*Bos bison*) are solely critical to the maintenance and conservation of the North American Great Plains. This is a simplistic and unrealistic understanding of the grazing process and the importance of grazing to conserve grassland ecosystems. It has been noted that ecosystem management of grasslands is more dependent on pyric-herbivory in complex landscapes than on the present or absent of specific species of grazing animals. Pyric-herbivory is herbivory promoted through the use of fire (Figure 8). It has been demonstrated from

**Table 1. Habitat requirements of the Lesser Prairie-Chicken. Being able to provide all of these habitat elements requires a heterogeneous landscape.**

| Habitat Requirements | Importance of Disturbance |
|---|---|
| Nesting | Minimal (lightly to ungrazed) |
| Brood rearing | Minimal to some (uneven grazing patterns) |
| Foraging | Some (recovering heavily grazed) |
| Leking (booming grounds) | Substantial (fire-grazing) |

Adapted from Taylor and Guthery 1980.

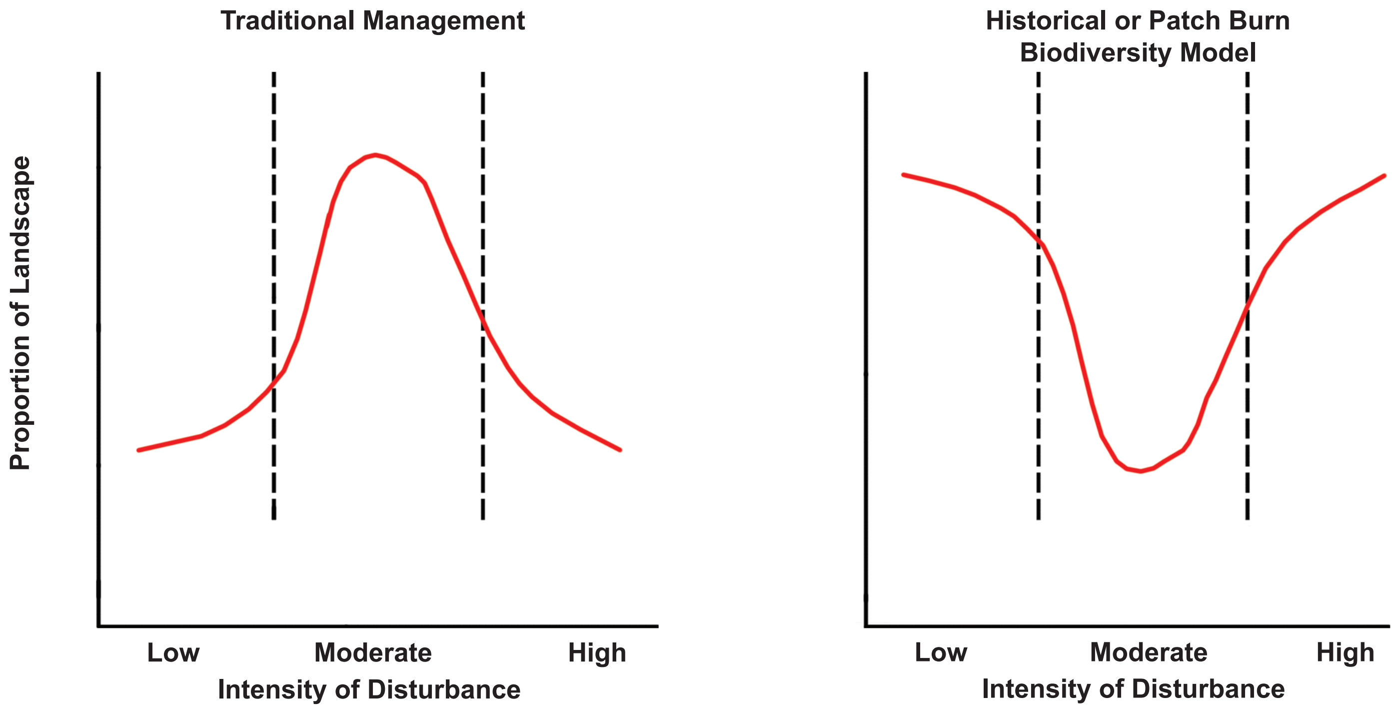


**Figure 6. To maintain biodiversity in the Great Plains, avoid the traditional management toward the middle of uniform moderate disturbance (homogeneity) and strive to manage for the entire spectrum of disturbance (heterogeneity).**

**Figure 7. The historical fire-grazing interaction that occurred throughout the Great Plains was a shifting mosaic of disturbance across the landscape that included areas that were burned, grazed, burned and grazed, along with areas that were not disturbed. A wide variety of herbivore species were attracted to the highly palatable forage on the recently burned areas. Photo by Stephen Winter.**

**Figure 8. Pyric-herbivory is herbivory shaped by fire. Ecosystem management of grasslands is more dependent on pyric-herbivory in complex landscapes than on species of grazing animal. Photo by Stephen Winter.**

our research on patch burning that the fire-grazing interaction is critical in maintaining heterogeneity of grassland ecosystems and that heterogeneity increases biodiversity and maintains system sustainability. The responses of native plant and animal species are used as indicators of restoration of the historical function in grassland ecosystems. A focus on introducing specific species of grazing animal, such as bison, may have important conservation implications to that species, but will likely have minimal impact on the conservation of grassland landscapes unless interactive influences of fire and grazing are considered.

## What is Patch Burning

Patch burning is the purposeful grazing of a section of an landscape or management unit that has been prescribed burned, and then burning another section to move the grazing pressure, thus creating a shifting mosaic on the landscape or management unit (Figure 9). Patch burning allows livestock to freely select the most recently burned part of a unit or pasture. Livestock spend 75% of their time on these patches and typically evenly utilize all the palatable plants within the entire burned patch (Figure 10). Then within 6 to 12 months burn another portion of the unit. This will shift the focal grazing point to the new burn patch (Figure 11). After the heavy utilization (1.5 to 2.5 years post burn) a transition state of bare ground, forbs, and low amounts of standing biomass and litter occurs. Within 2.5 to 3 years post burn the patch receives very little grazing pressure, which allows biomass and litter to accumulate (Figure 10). This patch is then ready to be burned and grazed again. This is all accomplished without fences or other management input besides the use of prescribed fire.

## Benefits of Patch Burning

### Vegetation

Patch burning through preferential grazing of burned patches promotes a diversity of plant species (Figure 12). An abundance of forbs (broadleaf herbaceous plants) can be expected to increase following the fire and heavy grazing pressure of focal grazing for several years following burning (Figure 13). Forbs contribute an important element to wildlife habitat, as well as benefits to livestock. Given time to recover from focal grazing, the forb community changes (Figure 12).

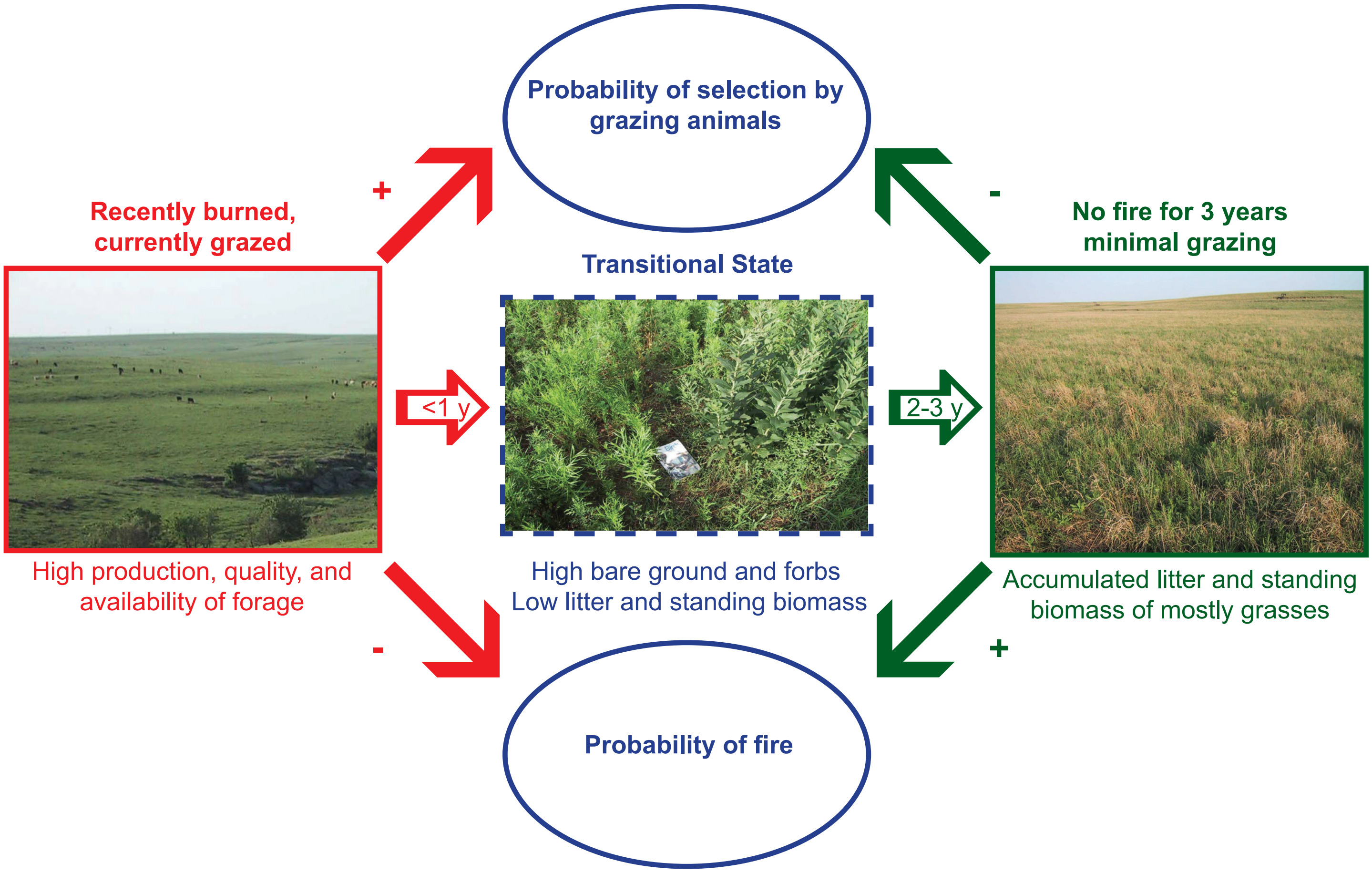


**Figure 9. A conceptual model demonstrating the dynamics of a patch within a shifting mosaic landscape where each patch is experiencing similar but out-of-phase dynamics. Ovals represent the primary drivers (fire and grazing) while squares represent the ecosystem states within a single patch as a function of time since focal disturbance. All states have the potential for fire or grazing. Solid arrows indicate positive (+) and negative (–) feedbacks in which plant community structure is influencing the probability of fire and grazing.**

**Figure 10. Cattle spend 75% of the time grazing on the most recently burned patches (foreground). This allows previously burned patches to recover from the intense grazing pressure (background). Photo by Samuel D. Fuhlendorf.**

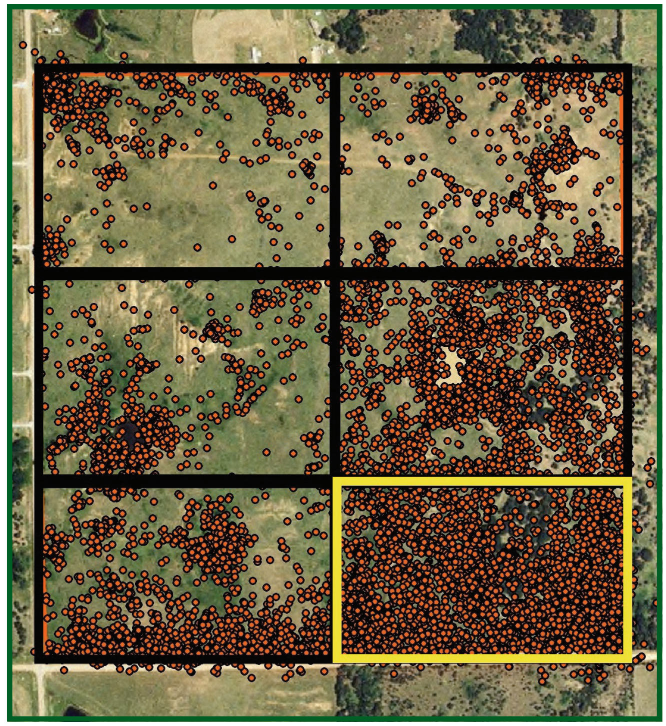

**Figure 11. Grazing distribution of cattle fitted with GPS collars (red dots) on patch burned pasture showing how much livestock select the most recently burned areas. The yellow outlined patch is the most recently burned patch, with the patch directly to its left was burned 4 months prior to it. The patch directly above it was burned the year prior to those two and has a water source in it.**

Increases in some invasive plant species can be constrained by either intense grazing or growing season burns. This has been demonstrated in research with sericea lespedeza (*Lespedeza cuneata*) in tallgrass prairie (see invasive plants section).

## Forage Quality

One of the effects of fire is the increase in forage quality of post-fire regrowth (Figure 13). Fire will remove old, standing dead plant material that is coarse and low in forage quality. After a fire, plant regrowth is young, green, and considerably higher in quality. When compared to areas that haven't burned, animals are attracted to this regrowth and will preferentially graze such areas. This attraction is one of many mechanisms that perpetuate patch burning (fire grazing interactions).

## Soils and Nutrient Cycling

Fire and grazing are interactive disturbance processes that are important to the structure and function of grassland ecosystems including the soils. There have been numerous studies of nitrogen (N) availability in grasslands that have reported different effects following grazing and fire. However, these studies have largely neglected the interaction between fire and grazing. When comparing patches within a patch burn system it was found that N availability was highest on the most recently burned and grazed patches relative to the previously burned and grazed patches (Figure 14). Nitrogen availability was also compared to an annually burned and grazed pasture, with N availability being greater on the patch burn sites (Figure 15). This greater N availability assists with creating great plant diversity across the patch burned landscape and providing nutritious forage for livestock and wildlife.

## Wildlife

The creation of diverse habitats for single or multiple animal species is the main benefit from patch burning (Figure 4, Table 1). Creating varied habitats increases the diversity of species on a given area (Figures 16, 17, and 18). This increased diversity of habitats and species has the potential to increase recreational lease opportunities, along with aesthetic values of the area. Again patch burning gives control of invasive plant species, such as eastern redcedar (*Juniperus virginiana*) and sericea lespedeza, which can be detrimental to many species of native wildlife.

Wildlife, regardless of species, require some level of habitat diversity. Healthy wildlife populations cannot be maintained by monocultures of plants or structure that is uniform. So by mimicking natural disturbance processes across the landscape, we can create the appropriate mix of plant communities and structure that is necessary for the survival of various wildlife species. With patch burning, the most important consideration for wildlife is the scale of disturbance. The timing or frequency of the burn should imitate historic fire regimes if overall biodiversity of native wildlife is the goal. If a specific species is of primary concern, then the timing or frequency of the fire may be altered to maximize production of that species.

The size of the burn should match the scale of the wildlife species being managed for. Northern Bobwhite (*Colinus virginianus*) require smaller patches than do whitetailed deer (*Odocoileus virginianus*). By varying the size and the number of patches, habitat for all species of

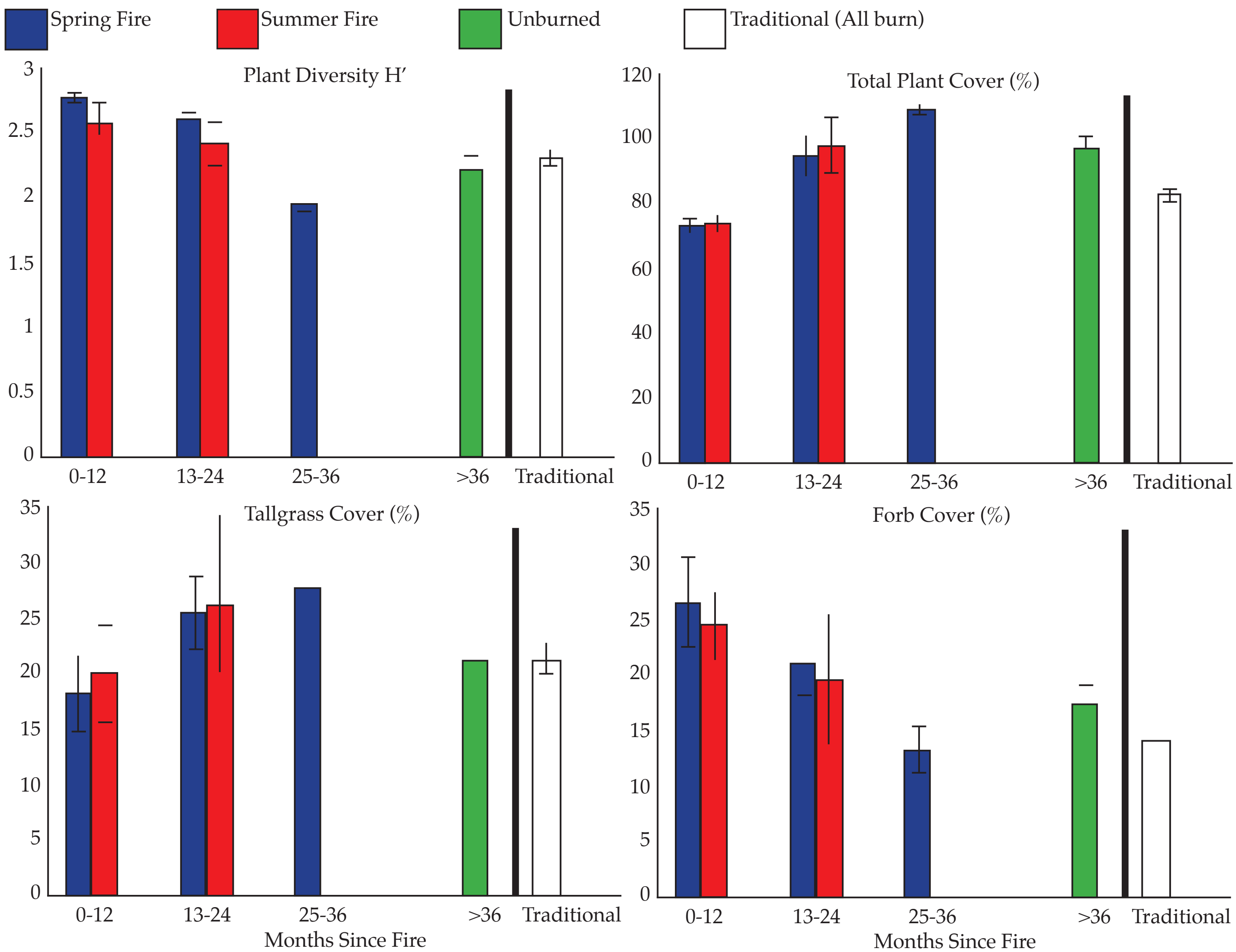


**Figure 12. Plant diversity, total plant cover, tallgrass cover, and forb cover are greater for patch burning than the traditional management practice of grazing and burning the entire pasture. Note how forb cover increases right after fire, and then reduces with time.**

wildlife can be optimized across the landscape. This illustrates how adaptive the patch burn system is, and how it can be modified to meet individual animal species and land manager objectives.

## Domestic Livestock Production

### Animal Performance

In studies comparing patch burning to pastures managed with traditional management practices, weight gains of stocker cattle did not differ. This is from four years of data taken from tallgrass prairie at the OSU Research Range (OSURR) located west of Stillwater, Oklahoma (Figure 19), and from nine years of grazing data from mixed-grass prairie at the Marvin Klemme Range Research Station (MKRRS) near Bessie, Oklahoma (Figure 20).

Preliminary data suggests that patch burning has the greatest benefits to cow-calf operations, if patches are burned in different seasons of the year. Body condition score of cows, and calf weight gain were the same for patch burning and traditional management pastures in four years of observations on spring-calving cows on the OSURR (Figures 21 and 22). Because growing-season burns (July-August) provided access to high quality forage during the fall months (Figure 13), the patch burn cows were not fed any supplement until the first of January every year (Figure 23). In contrast, the traditionally managed cows were provided protein supplement starting the first of November each year. This reduction in supplemental feeding and other associated costs is a meaningful economic benefit of patch burning to the producer.

### Ticks

Ticks are a major pest of cattle and constraint to the livestock industry. They are obligate blood feeding parasites that in high densities can impair growth and productivity of cattle. Ticks burden their hosts through their feeding, which results in blood loss, irritation, and increased susceptibility to secondary infections. Tick populations also serve as vectors of bacterial, rickettsial, viral, and protozoal disease agents to livestock, humans, and other animals. From a study comparing patch burn-

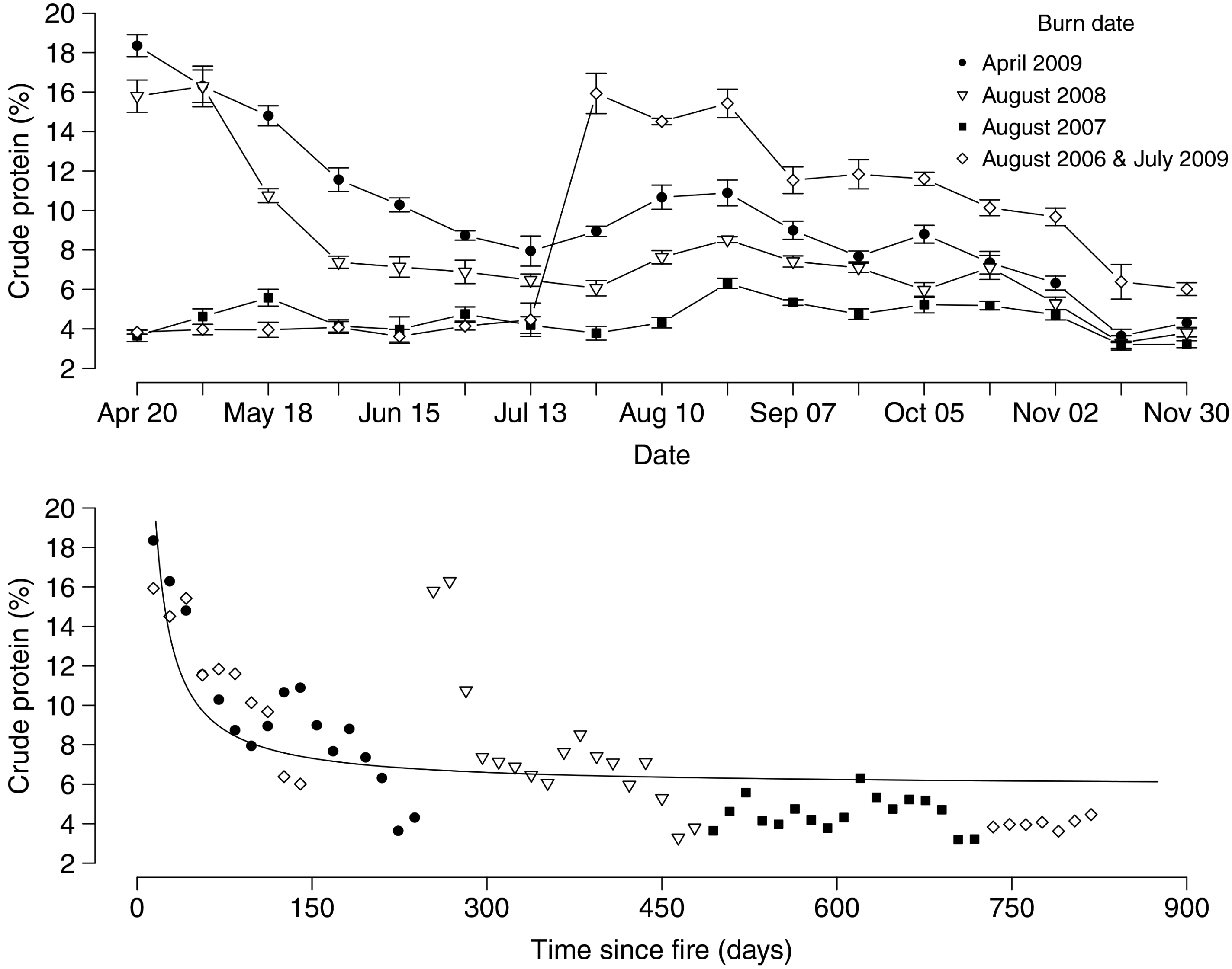


**Figure 13. The effects of fire on forage quality (% crude protein) throughout the growing season of 2009. Data were collected from pastures that are managed with patch burning. Different symbols represent areas that vary in the time since burned. Recently burned areas (less than one year since fire) contain higher forage quality. A prescribed fire in mid-July increases quality of forage, raising it significantly higher than other areas. This increase remains through the end of the growing season. The amount of time since a particular area has been burned determines the forage quality available to animals.**

**Figure 14. The patch on the left was burned in September 2002. The patch on the right was burned March 2003, and the picture was taken in September 2003 showing the variation of plants created by patch burning and grazing. Photo by Bob Hamilton.**

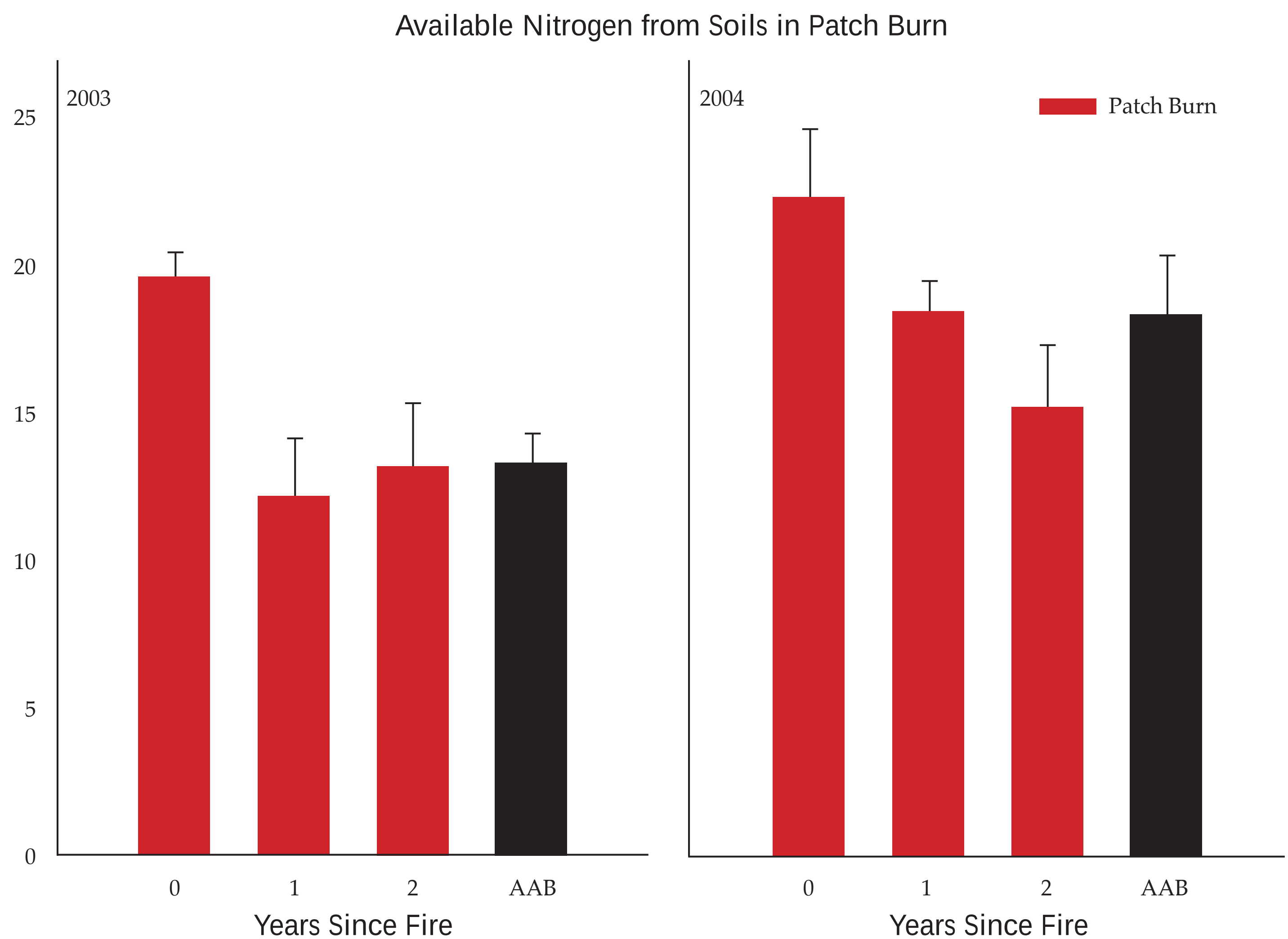


**Figure 15. Plant available nitrogen is greater under patch burning than from grazing and annually burning the entire pasture (AAB). AAB is a practice common in the Flint Hills of Kansas and Osage Hills of Oklahoma.**

Pictures by Gary Kerby

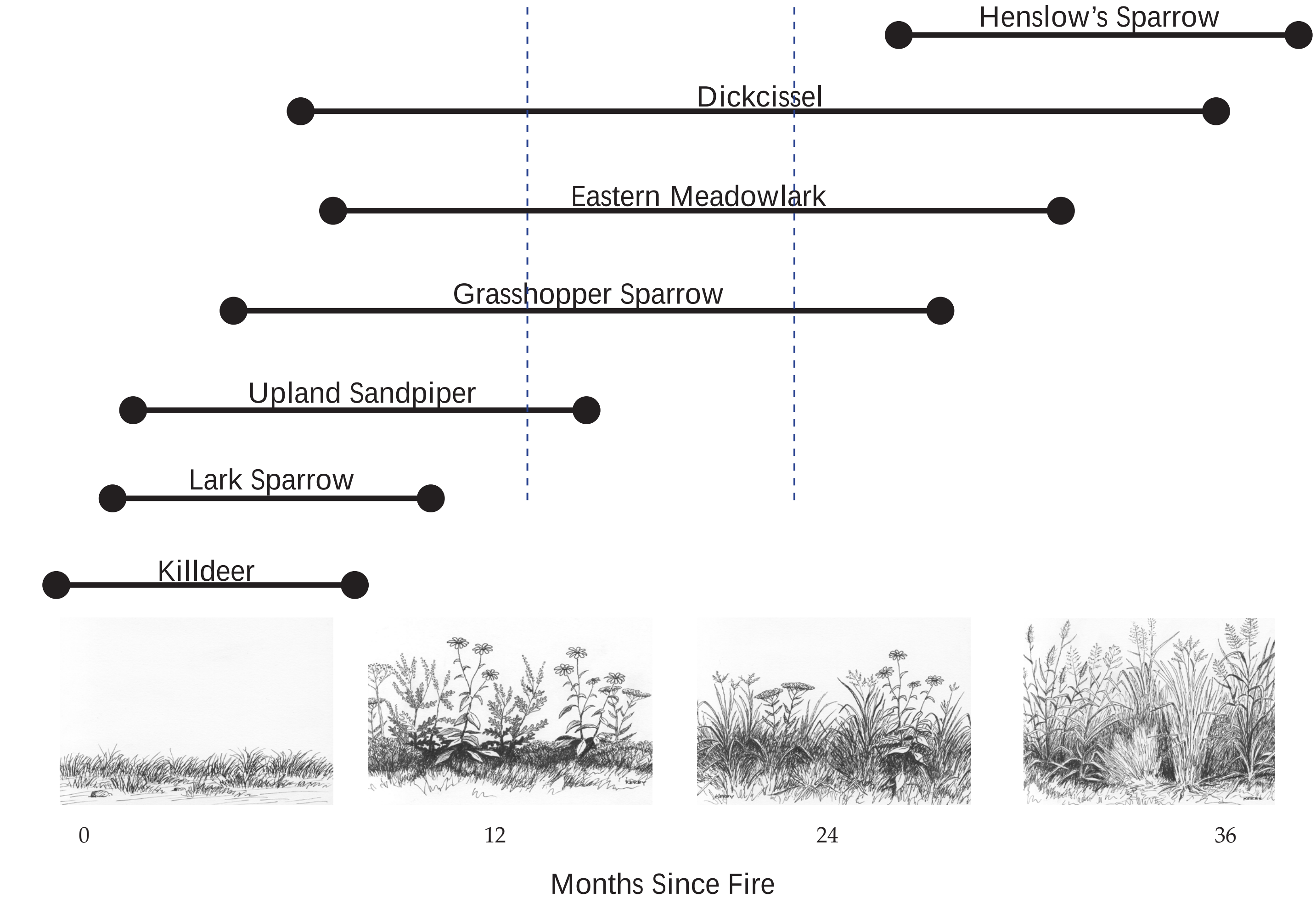


**Figure 16. The range of habitat required by prairie songbirds. Patch burning allows for multiple habitats (heterogeneity) with the same unit for multiple species, whereas traditional management generally provides only one kind of habitat structure.**

ing to burning the entire pasture once every three years in Oklahoma it was found that cows and calves on patch burn treated pastures had significantly less numbers of ticks on them than the burned once every three year pasture (Figure 25). The study looked at tick numbers from April to October and found that on cows, overall number of ticks was reduced by patch burning in April, May, June, and September. While the overall number of ticks on calves was reduced in May, June, July, and September in patch burn treated pastures. The study concludes that even though the older patches in a patch burn pasture have reestablished leaf litter and biomass which creates favorable tick habitat, cattle do not spend much time in them, thus the cattle have fewer ticks.

## Horn Flies

Horn flies (*Haematobia irritans* L.), a serious pest in cattle grazing operations, cause more than $1 billion in losses in the US each year. Cattle serve as a host to horn flies, which feed on cattle for blood meals and use cattle feces to lay eggs. Production losses are attributed to blood loss, weight loss, stress from annoyance and decreased milk production. Treating cattle for horn flies improves calf weaning weights, yearling cattle gains, and maternal milk production. Unfortunately, most treatment options rely on insecticides, to which horn flies rapidly develop resistance and add production costs to the operation.

Horn fly populations on cows in patch-burn grazed pastures were compared to cows in traditional grazed pastures that were not burned in early summer when horn fly populations are highest. All other variables, including stocking rate, were equal between pastures. Cattle in pastures managed with patch-burning had 41% fewer horn flies (119 flies per cow side) than cattle in pastures that were not burned (201 flies per cow side). Cows in patch-burn treated pastures were near the economical threshold suggested for treating for horn flies (100 flies per cow side), but cows in unburned pastures were double the threshold. These horn fly numbers suggest that cows on patch-burned pastures would have higher grazing time because stress annoyance behaviors (head throwing, tail flicking, twitching, leg stomping) would be decreased. This patch-burning treatment effect is possibly due to cattle spending more time in recently burned patches than unburned patches, and fires altering cattle fecal pats that are overwintering locations for horn flies. By moving fire and grazing around the landscape through space and time, patch-burning disrupts the biological cycle of horn flies.

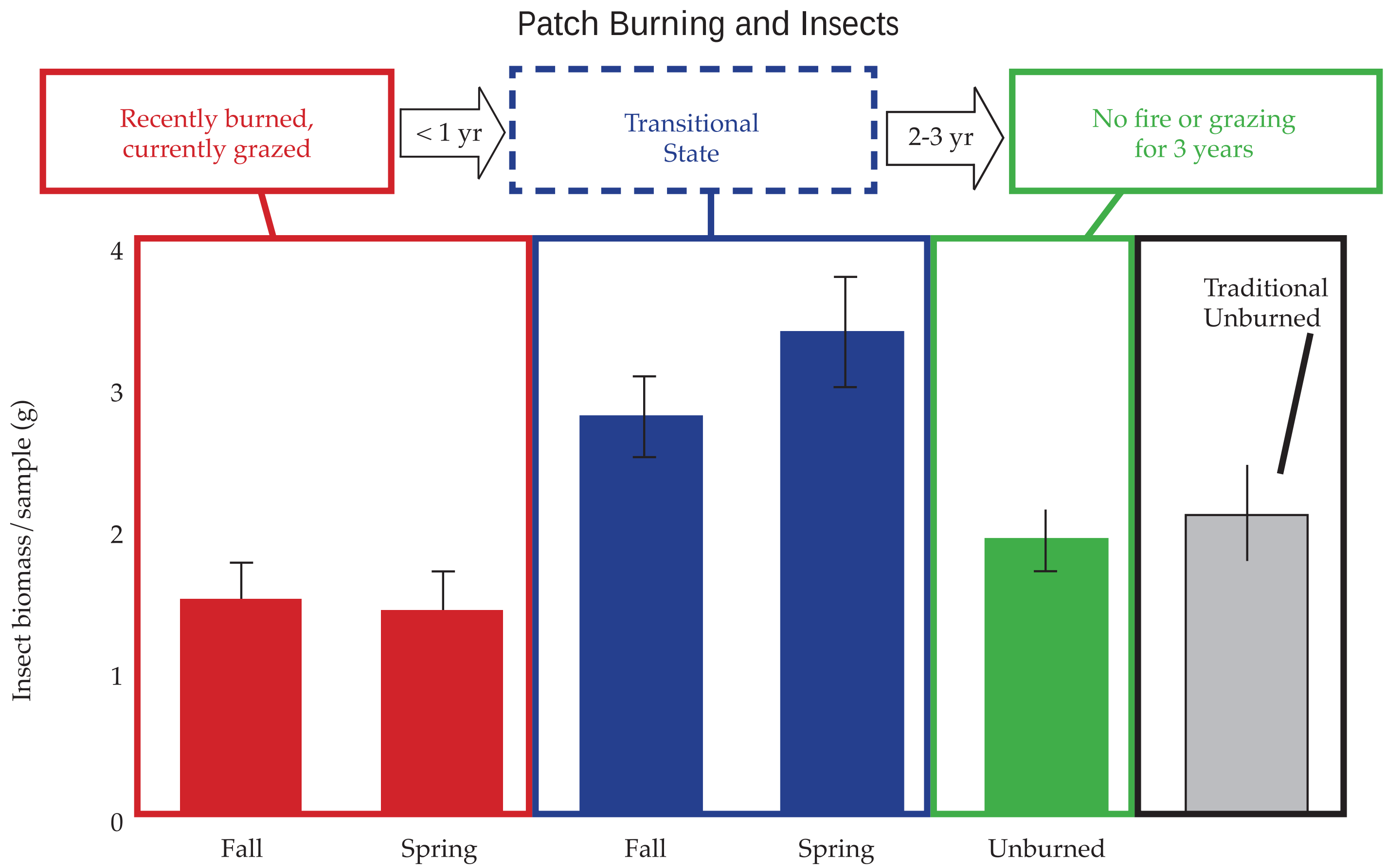


**Figure 17. Insect biomass compared between patch burn patches and traditional management. The greatest biomass is found in the transitional state, which are brood rearing areas for many bird species.**

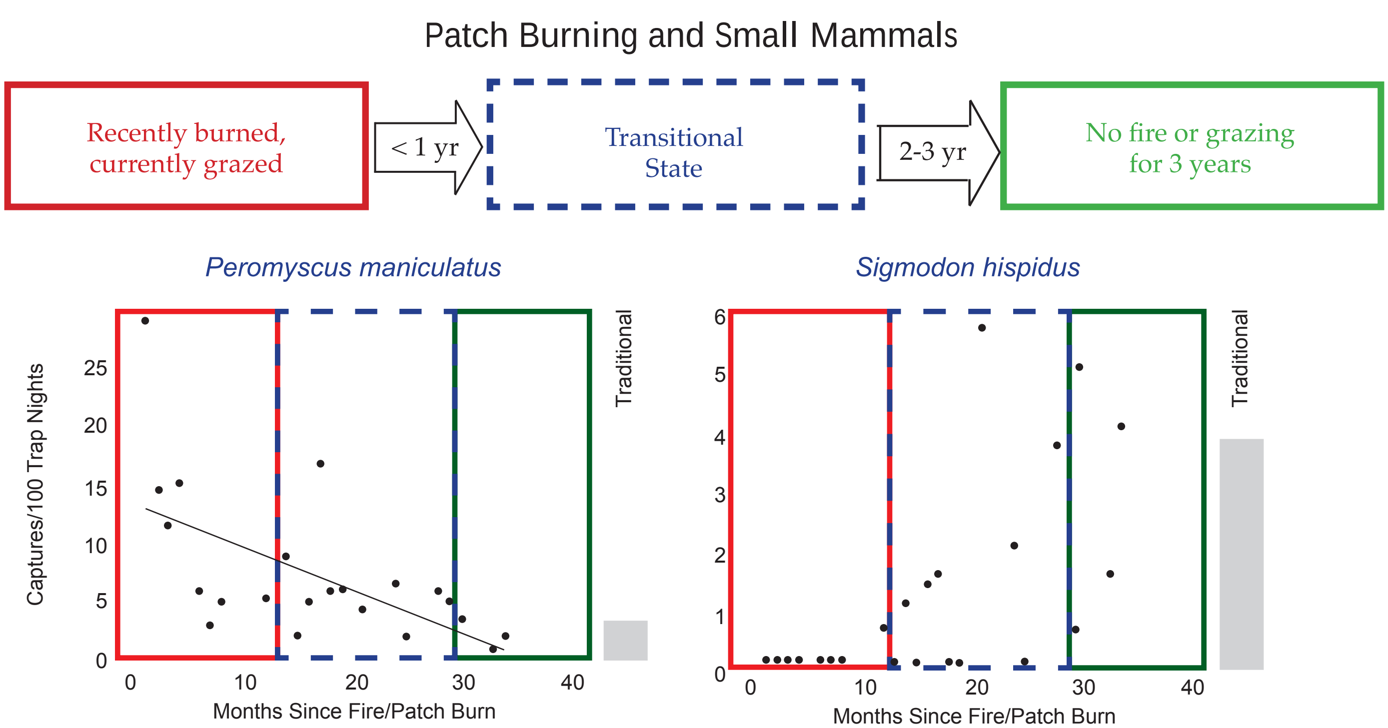


**Figure 18. Number of captures of white-footed deer mice (*Peromyscus maniulatus*) and cotton rats (*Sigmodon hispidus*) between patch burn patches and traditional management practices. Heterogeneity from the patch level to the landscape level is essential to meet habitat requirements of multiple species.**

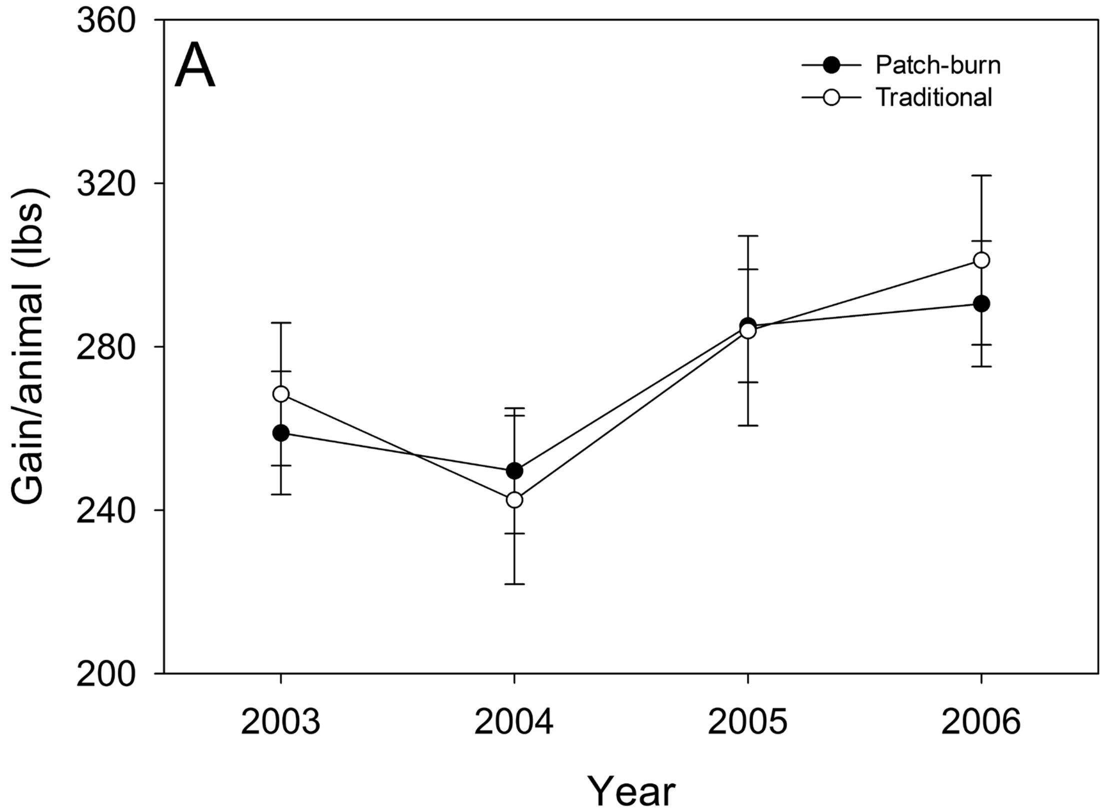


**Figure 19. Gain/acre (lb) of yearling steers at the OSU Research Range located at Stillwater, OK.**

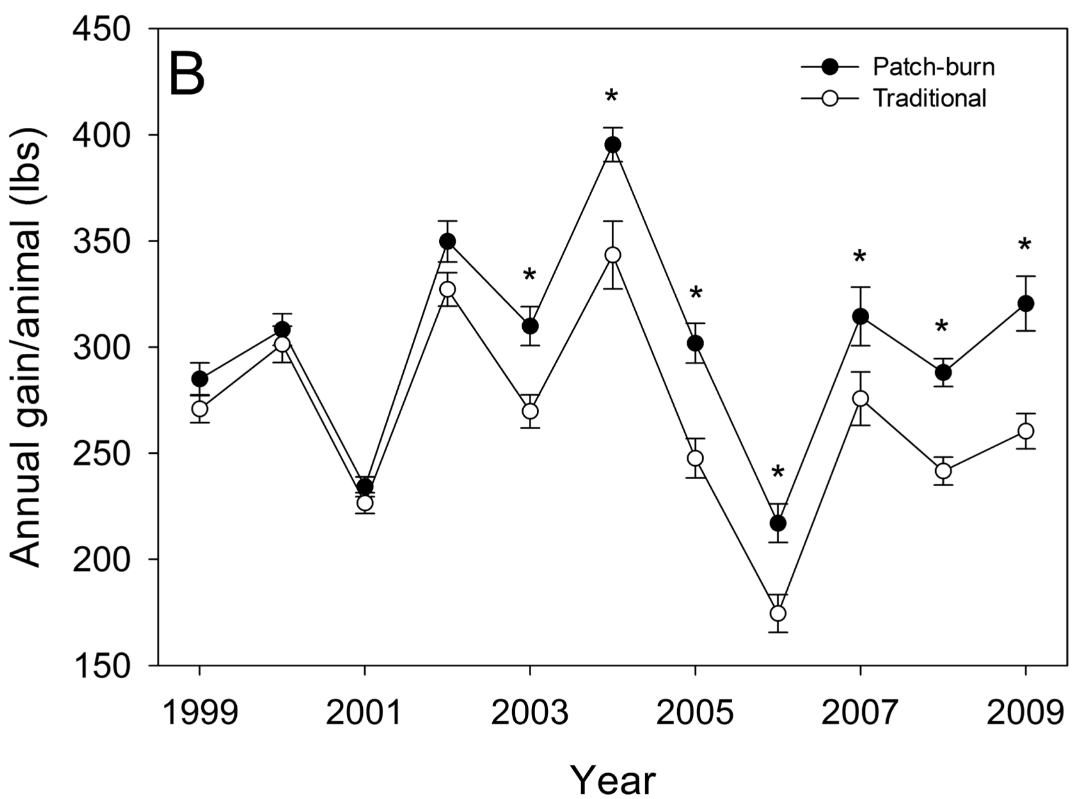


**Figure 20. Gain/acre (lb) of yearling steers at the Marvin Klemme Range Research Station located at Bessie, OK.**

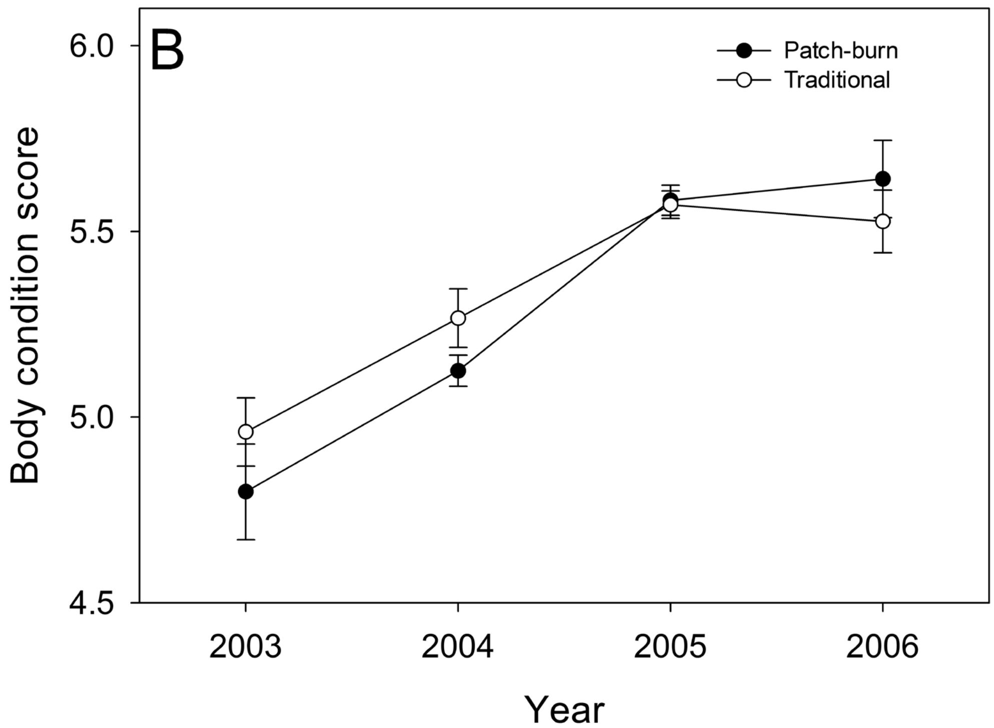


**Figure 21. Body condition scores of cows on pastures managed with patch burning and traditional management at the OSURR did not differ over four years. Cows on patch burned pastures where also fed 120/lbs per head less supplement during the winter months (supplemented from January 1 to April 1) than the traditionally grazed cows (supplemented from November 1 to April 1).**

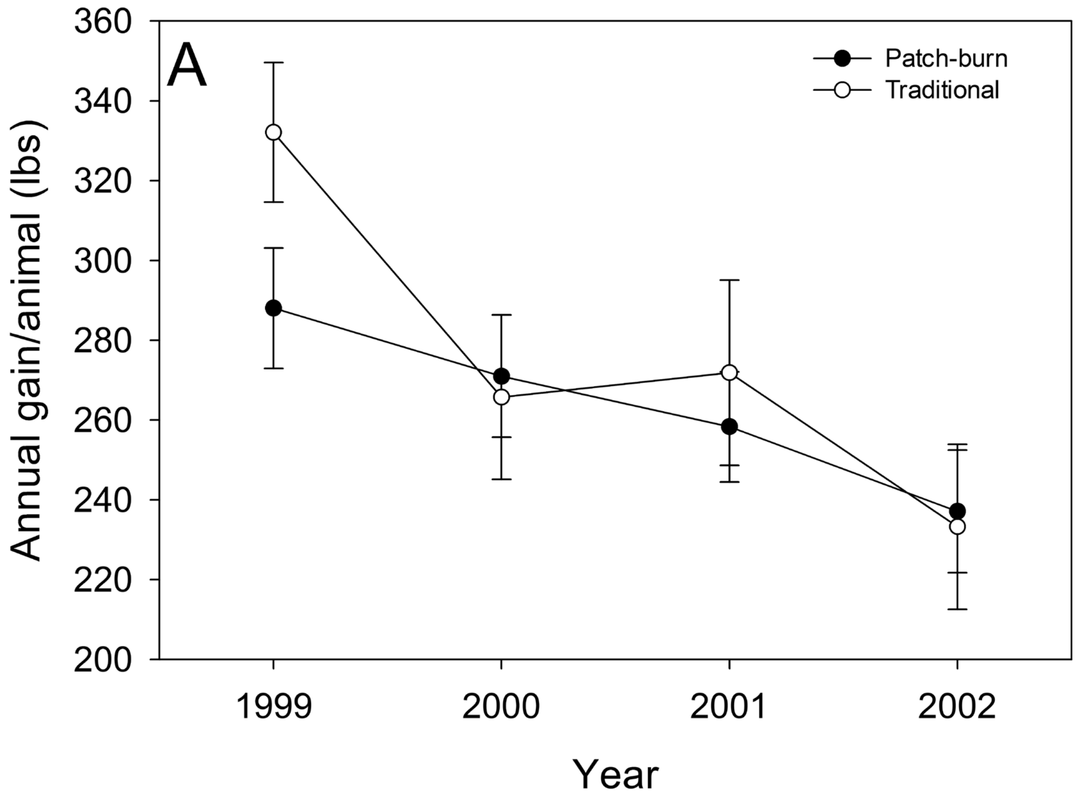


**Figure 22. Calf weight gain on pastures managed by patch burning and traditional grazing did not differ.**

**Figure 23. Late summer burns (area cattle are on) provide cattle with access to high quality forage late into the fall months, thereby reducing protein supplements and associated costs. Photo by John R. Weir.**

Other benefits of patch burning to livestock production include:

- Uniform utilization of forage over the entire pasture over a period of years.
- Ease of checking cattle.
- Deferred grazing before or after burning is not required and livestock can be left in the pasture while burning the next patch.
- Forage accumulated in rested patches is a form of grass banking, which is holding forage in reserve for drought.
- Better brush control because fire in rested patches is more intense than in pastures managed traditionally.

## Prescribed Fire Program

Patch burning benefits all aspects of a prescribed burning program. The major benefit of patch burning is the additional accumulation of fine fuel, which is readily achieved without any deferment of grazing before or after burning (Figure 26). With larger amounts of fine fuel, burns can be conducted under safer weather conditions, including lower air temperature and higher relative humidity (Figure 27). With greater amounts and more continuous fine fuel loads, fires can be more intense, which results in better suppression of woody plants (Figure 28). We have observed numerous large eastern redcedar trees killed with fire in patch burned pastures that had escaped several previous prescribed burns under traditional management (continuous grazing with a 3-year fire-return-interval).

Patch burning allows prescribed fires to be conducted at different times of the year, which can spread out the burn season and provide more time to conduct fires. Days with adequate weather conditions are limited during traditional burning seasons, which cause burn bosses to push the edge of safety by burning on days with marginal weather conditions, or not to conduct burns at all. Therefore, a manager whose objective is a 3-year fire-return-interval often is unable to achieve the objective with traditional management practices because of limited available burn days within prescription.

Another benefit of patch burning is that fires can be allowed to burn into previously burned areas making

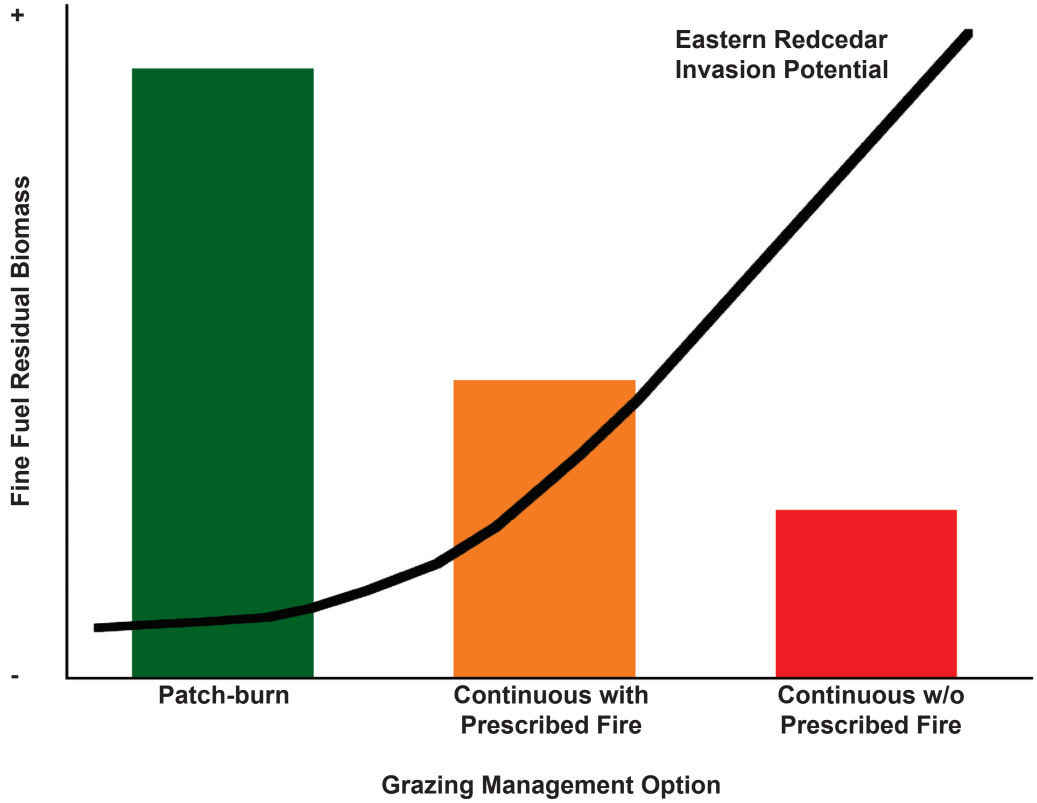


**Figure 24. Effect of three fire-grazing management options on fine fuel residual biomass and subsequent potential for eastern redcedar invasion. Patch burning allows portions of the management unit that have not been recently burned to accumulate fine fuel. This enables prescribed fires to effectively control eastern redcedar. In contrast, continuous grazing with fire at similar stocking rates does not provide adequate fuel accumulations for any part of the management unit, which reduces a prescribed fire effectiveness to control eastern redcedar. Grazing without prescribed fire allows eastern redcedar to decrease fine fuel production over time.**

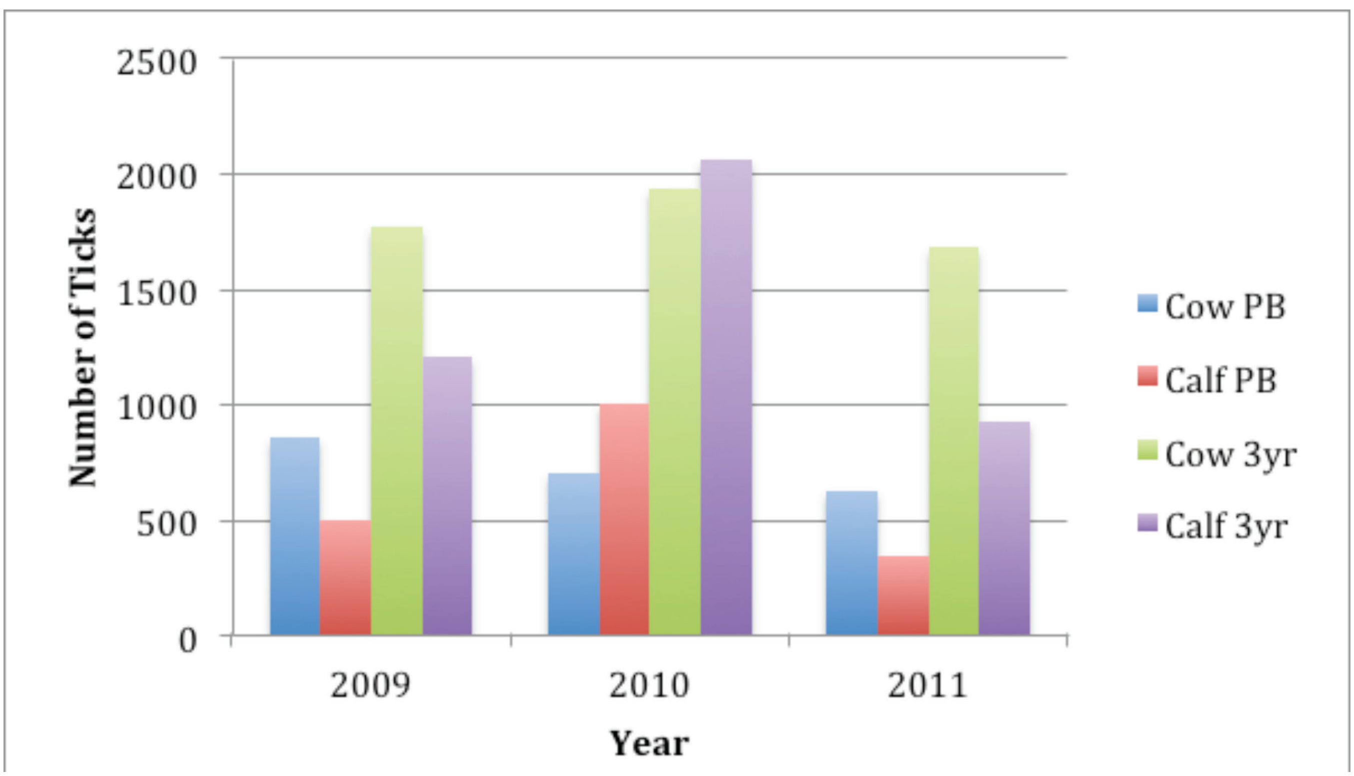


**Figure 25. Total number of ticks on cows and calves on patch burn pastures (PB) and burned once every three (3) years. The burned once every three-year pasture was burned in 2009. Even though the older patches in a patch burn pasture have reestablished leaf litter and biomass which creates favorable tick habitat, cattle do not spend much time in them, thus the cattle have fewer ticks. (Source Polito 2012)**

prescribed burns safer and easier to conduct. The previously burned and grazed patches contain insufficient fine fuel to carry a fire. We recommend planning prescribed burns to utilize these preburned areas as firebreaks as much as possible (Figure 29).

Because patch burning reduces the size of the burn unit, burning smaller units can make the prescribed fire operation less complicated and costly. It may require fewer personnel and less equipment to conduct the burn than when an entire pasture is burned. Burning smaller units produces less smoke and minimizes smoke management issues. The amount of time spent patrolling the fireline and in post burn mop-up is also reduced.

## Invasive Plants

Invasive plants can either be native or exotic and are defined by their ability to rapidly increase in vegetative cover, the rate and extent of land area they occupy, and their ability to disrupt an existing ecosystem. While most plant species stay within a set area and have herbivores or other limitations to their expansion, invasive plants tend to be highly competitive and exhibit traits that deter herbivory, insects, or disease. By displacing native plants, these invasive plants often become the dominant plant species in sensitive areas, thus altering the ecosystem and the organisms that utilize it.

Sericea lespedeza is an invasive herbaceous plant species that impacts many parts of the southern Great Plains. Sericea lespedeza is native to East Asia and was introduced into the U.S. in 1896 as a forage plant. It is also planted for erosion control, land reclamation, and hay across the eastern U.S. Germination occurs in spring and it flowers between August and October. However, the aggressive growth of the plant and prolific seed production allow it to quickly escape cultivation and invade adjacent native prairie. The coarse, persistent stems deter grazing of young tender shoots the following season, thus allowing the plant to grow and reproduce if control measures are not taken. Herbicide applications can effectively control existing plants of sericea lespedeza, but these herbicides are expensive and detrimental to

**Figure 26. Accumulating fine fuel for conducting prescribed burns increases with patch burning. The patch on the left was the last one burned and grazed. The patch on the right was burned and grazed three years previous and it is the next patch to be burned. Photo by John R. Weir.**

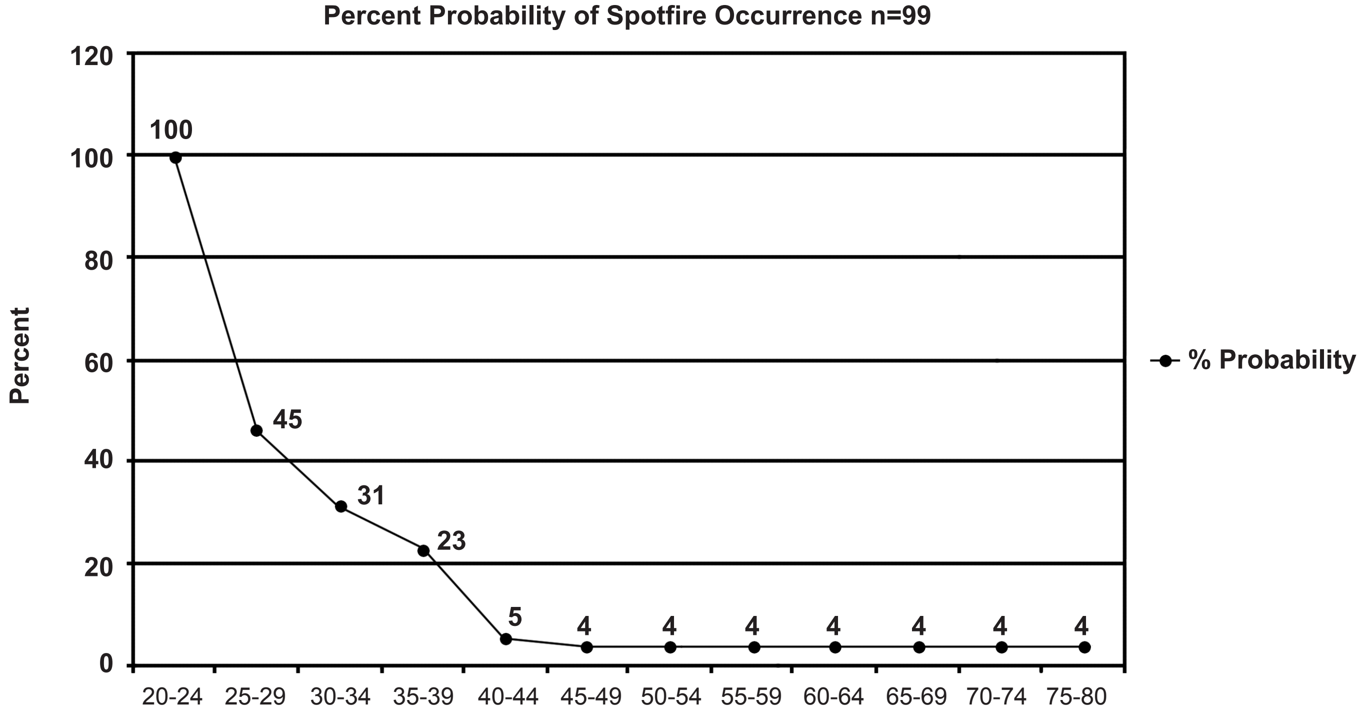


**Figure 27. Burning with higher fine fuel loads allows prescribed fires to be conducted with higher relative humidity, which reduces the probability of spot fires (source Weir 2004).**

the native trees and forbs that are important wildlife and livestock forage.

Patch burning allows livestock to graze sericea lespedeza, keeping it short and palatable (Figure 30). Patch burning has also been shown to decrease the rate of invasion by three times the invasion rate of traditional management (Figure 31). In addition, summer fires within the patch burning treatment appear to decrease the sericea lespedeza cover even more than the spring patch-burns (Figure 32).

Eastern redcedar is an example of a woody plant species that is invading the grasslands, shrublands, and forests of the Great Plains (Figure 33). This evergreen is a native, nonsprouting, tree that was historically confined to river bottoms and draws where fire could not reach. But since the start of European settlement and fire suppression, this tree has begun to invade numerous habitats across the Great Plains. Patch burning has been found to be an effective management practice for controlling eastern redcedar. It allows areas to be burned that have had no history of fire, along with permitting greater accumulations of fine fuels for future prescribed fires. These larger fine fuel loads also allow for better control of larger trees, which are more difficult to control with fire under traditional grazing and fire systems.

## Fire Behavior

Fire and grazing are ecological processes that frequently interact to modify landscape patterns of vegetation. This alteration of the vegetation can have significant impacts on fire behavior, from creating areas that will not burn or producing locations that are extremely flammable and difficult to contain. Patch burning can also modify fire behavior, specifically when comparing the relationship between fire behavior and patch size of fuel heterogeneity.

The burn area (total acres), burn shape complexity (amount of fireline and shape of burn), and the proportion of area burnt by different fire types (headfire, backfire, and flankfire) are all affected by the patch size (Figure 34). The area a fire can burn in a heterogeneous landscape is related to the fuel load present in the patch where ignition occurs. Burn shape complexity is greater in landscapes with small patch size than in landscapes with large patch size. The proportion of each fire type (backfire, flankfire, and headfire) is similar among all landscapes regardless of patch size but the variance of burned area within each of the three fire types differs among size of patches.

This landscape fire simulation (Figure 35) shows that patch burning can be very beneficial for reducing fuels, suppressing wildfire, and making fire containment easier and safer. The positive advantages of patch burning can be accomplished through creation of blackened areas, grazing to reduce fuels loads, reducing the amount of fireline needed to be suppressed, and a decrease or removal of volatile fuels, such as eastern redcedar (Figure 36).

## Why Implement Patch Burning?

In several of the comparisons between patch burning and traditional management, no differences were found between the two practices. So if patch burning and traditional management do not differ, why use patch burning (Figure 37)?

**Figure 28. Patch burning increases fuel loading in unburned patches, which increases fire intensity and topkill of woody plants. The eastern redcedar in the foreground occurs in a pasture that was burned four times previously with traditional management practices (note lack of leaves in lower portion), but it was not killed because fire intensity was low and the tree's apex remained unscorched; because fine fuel load increases with patch burning, these larger trees will be eliminated. Photo by John R. Weir.**

**Figure 29. The sericea lespedeza plant on the left has not been utilized and the old stems deter grazing, which is characteristic of traditional grazing practices. The sericea lespedeza plant on the right has been burned and heavily grazed with patch burning. Patch burning increases palatability of sericea lespedeza by removing dead stems and stimulating new shoots to grow. Photos by D. Chad Cummings.**

We have found we can achieve more consistently the following outcomes with patch burning than with traditional management.

- Dependable use of prescribed fires.
- Greater fuel loads for prescribed burning.
- Ability to use prescribed burning without deferring grazing before burning.
- Does not require gathering or moving cattle before burning.
- Control of invasive plants without chemical or mechanical methods.
- Creation of a heterogeneous landscape that provides economic, environmental, and ecological benefits.
- Provides rest for each portion of a pasture for 2 to 3 years.
- Achieve uniform distribution of grazing use over the entire pasture (over a period of years).
- Manage for drought by stockpiling forage.
- Requires feeding less protein supplement in the winter.
- Provide habitat for species of wildlife native to grassland, shrublands, or forestlands.

With patch burning all of the above-mentioned benefits are attainable. So while there may be several aspects of patch burning that show no difference to traditional management, the overall benefits to the land and animals that use it are greater with patch burning.

## Implementing Patch Burning

Selecting the proper stocking rate on the unit is the most important step when planning a patch burn program. Most land managers believe that more is better, but research demonstrates that maximum net return per acre occurs at a moderate stocking rate (Figure 36). For the benefit of livestock, plant community, and wildlife proper stocking rate is crucial. Stocking rate is also important in patch burning because once patch burning is implemented, grazing is not deferred either before or after burning, and the livestock are left on the pasture the entire time (even while burning). Therefore, the proper stocking rate will provide two contrasting patch types: 1) a grazing lawn in the most recently burned patch, and 2) ungrazed grasses in the patch with the greatest time since the last burn (least recently burned patch). If stocking rate is too light, a grazing lawn will not occur in the most recently burned patch (i.e., the grass will be too tall to qualify as a lawn). If stocking rate is too heavy, grazing will occur in the least recently burned patch, and in the extreme, this patch will not carry a fire.

The next decision is to determine the fire-return-interval. In areas of higher rainfall (30+ inches per year),

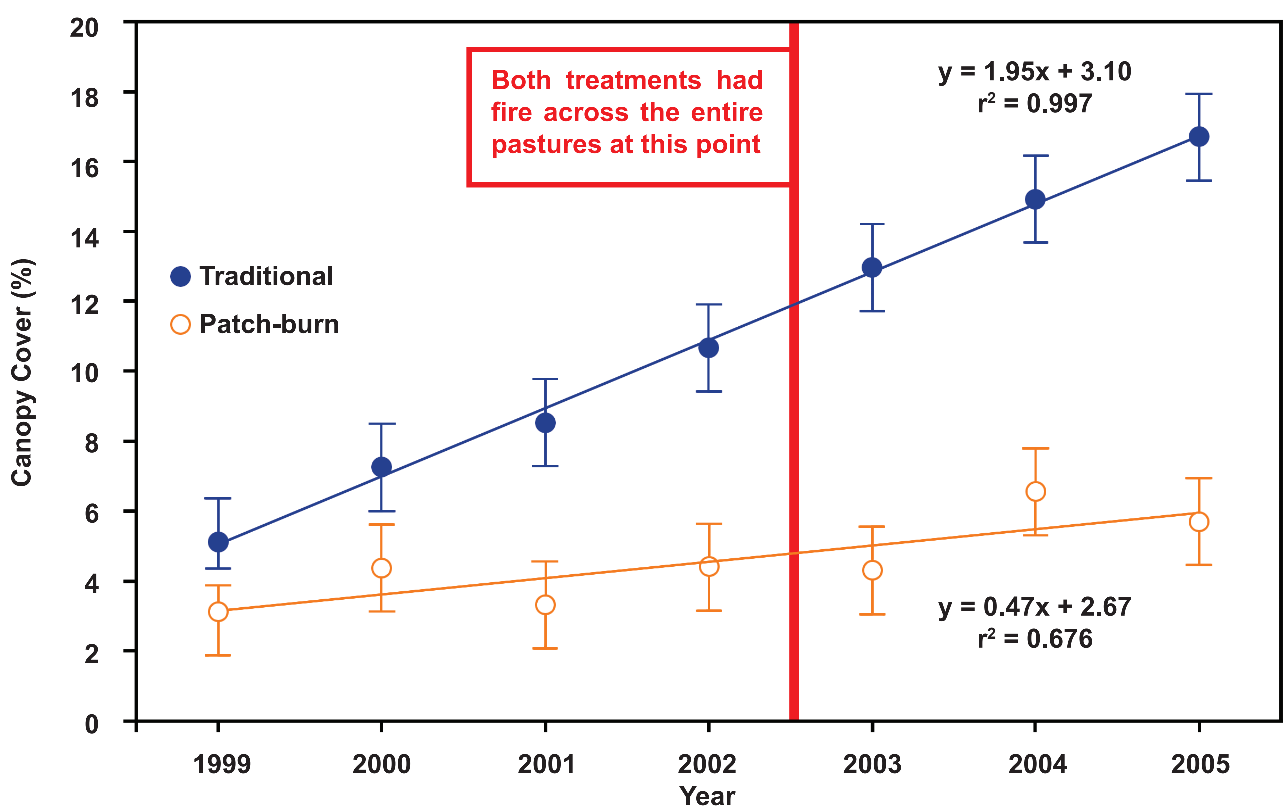


**Figure 30. Canopy cover of sericea lespedeza within pastures managed by either patch burning or traditional grazing management practices. Patch burning reduces sericea lespedeza while the traditional grazing management allows sericea lespedeza to increase at roughly a 2% increase in cover per year, three times the rate of increase in the patch burn treatment (source Cummings et al. 2007).**

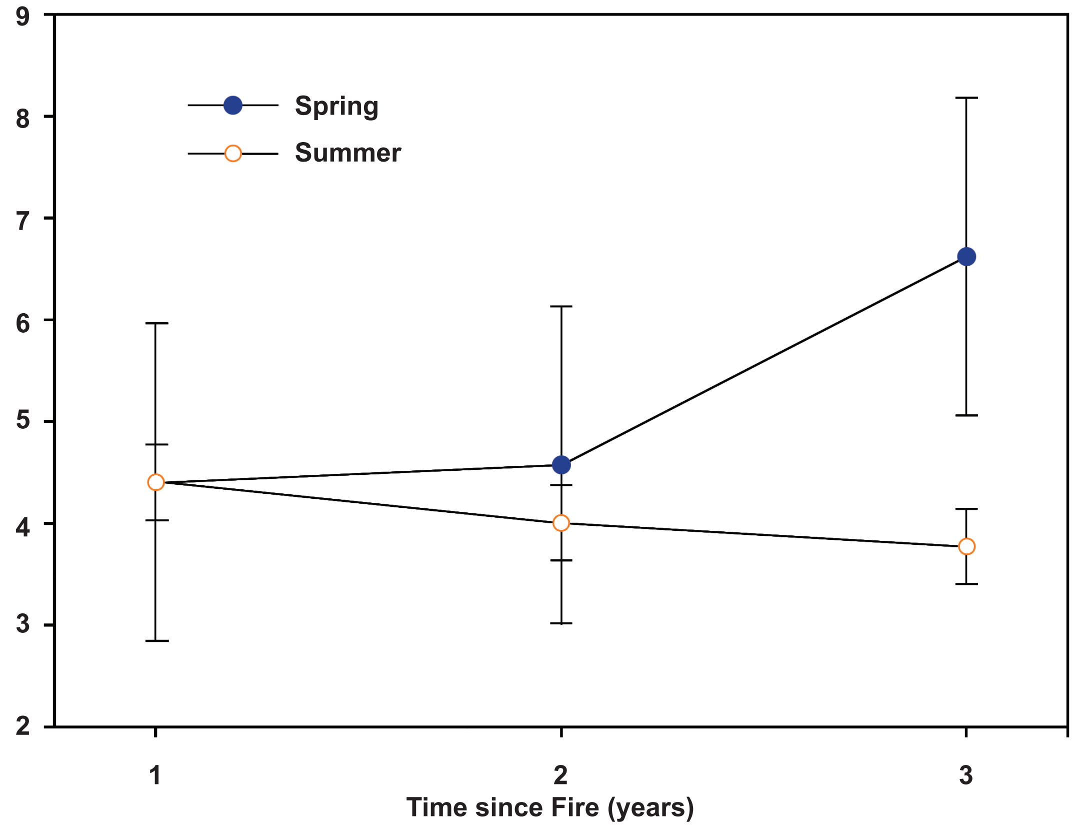


**Figure 31. Effect of season of burn (spring versus summer) within patch burned pastures on sericea lespedeza cover. Spring burning is less effective than summer burning (source Cummings 2007).**

**Figure 32. Encroachment of eastern redcedar into the tallgrass prairie in Oklahoma. Under continuous heavy stocking, eastern redcedar is capable of rapid invasion from seeds if prescribed fire is absent from the land. With patch burning, fine fuel for prescribed fires is accumulated over time, which provides adequate fuel for the intense fires necessary to kill the taller trees. Photo by D. Chad Cummings.**

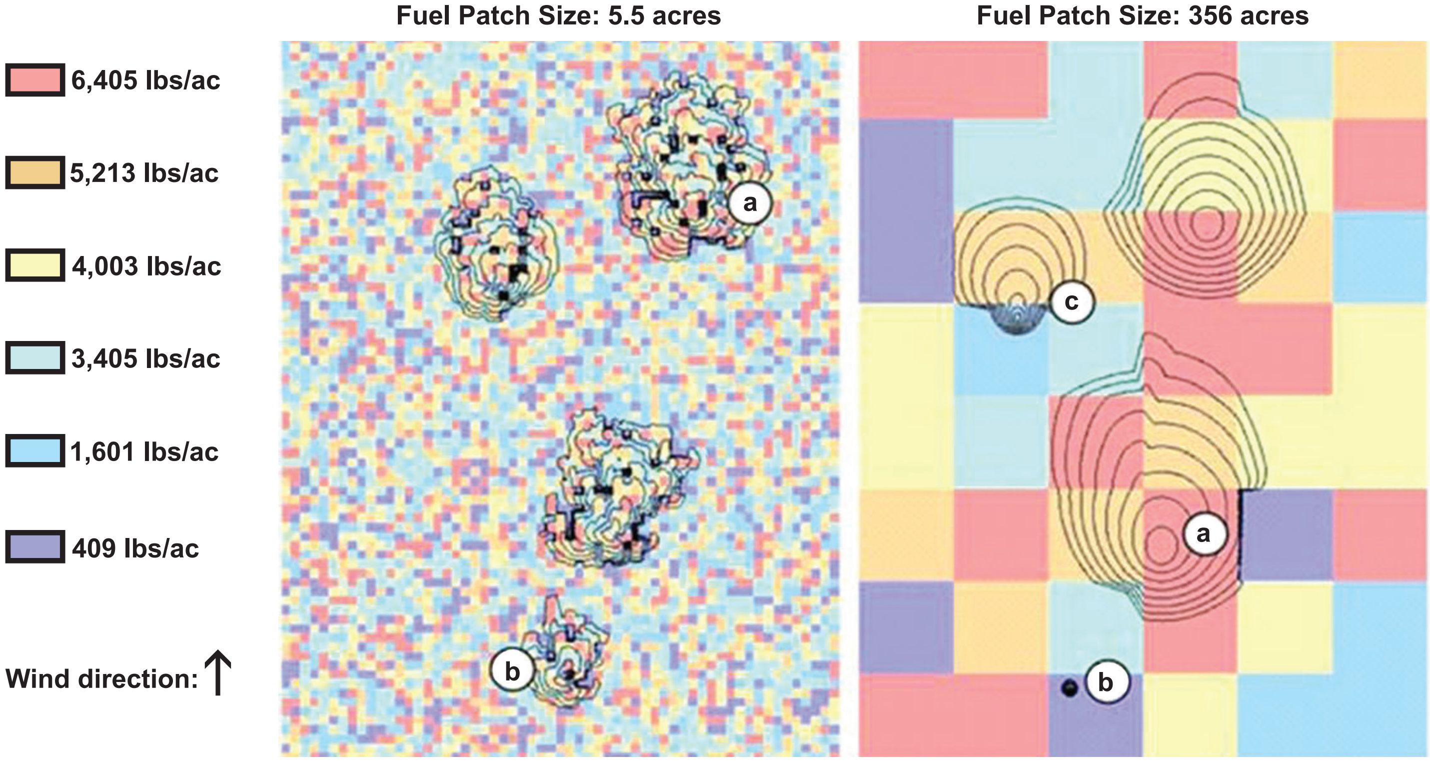


**Figure 33. Landscape fuel maps and examples of fire spread with different patch sizes and different fuel loads (409 lbs/ac to 6,405 lbs/ac). The concentric rings demonstrate fire perimeter at 30-minute intervals for a 4-hour fire. All treatments of fuel patch size (5.5-acre and 356-acre are shown as examples here) had equal fuel loading when averaged across the entire landscape (3,405 lbs/ac). Fuel patch size and ignition point fuel load influence burn area; fire shape complexity; and proportion of headfire, backfire, and flankfire. Note that each fire was simulated independently and that multiple fire perimeters on these maps are for demonstration only (source Kerby et al. 2007).**

**Figure 34. With patch burning, a fire can be allowed to burn into the previous year's burned patch (left) because fuel is insufficient to carry a fire. This feature of patch burning makes suppression of wildfire, along with implementing prescribed fire, both safer and easier. Photo by John R. Weir.**

a fire-return-interval of 3 years has been used effectively. While in drier regions, a 4-year fire fire-return-interval might provide better results.

Once the fire-return-interval has been determined the land manager may want to consider burning in different seasons of the year. Growing season burns can be very beneficial for wildlife and livestock. For example, we found that a cow-calf enterprise can benefit with burning in both the dormant and growing season because the contrasting burn seasons provides patches with higher quality forage during different times of the year.

After deciding on fire return interval and burning season, simply divide the pasture into the appropriate number of burn units. For example (Figure 34), for a 3-year fire-return-interval and burning in the both the dormant and growing season, divide the pasture into 6 patches. The patches do not have to be the exact same size, and patch boundaries can utilize existing county or pasture roads, creeks, or other natural barriers to reduce fire break construction and to facilitate safer and easier burning.

## Frequently Asked Questions About Patch Burning

1. *How large/small an area will it work on?*
   Currently there have been patch burn studies conducted on units as small as 100 acres to areas over 20,000 acres in size. The results are similar and have found many positive benefits of patch burn no matter the size of the unit.

2. *Will patch burning work in more arid parts of the country?*
   Patch burning has been conducted in areas with over 36 inches of annual rainfall to places that receive less than 18 inches of precipitation annually. In drier regions you may want to have a longer fire-return-interval, which coincides with fuel build-up. Patch burning conducted in these arid sections of the country has shown benefits to vegetation and wildlife, along with no differences on livestock production when compared to traditional management practices of the area. Historically fire occurred in all parts of the U.S., and if there was fire, grazing also occurred on these sites. Grazing may have not been carried out by large herbivores such as bison, but numerous other grazing animals of smaller size utilized these burned sites.

3. *Will patch burning work on reconstructed prairie or go back lands?*
   Yes, patch burning will work on these sites as well. The native vegetation that has been planted or allowed to grow back are the same species that

**Figure 35. With patch burning, land managers can control invasive plants without chemical or mechanical methods; create a heterogeneous landscape that provides economic, environmental, and ecological benefits; rest each portion of a pasture for 2 to 3 years; and achieve uniform distribution of grazing use over the entire pasture (over a period of years). Photo by Stephen Winter.**

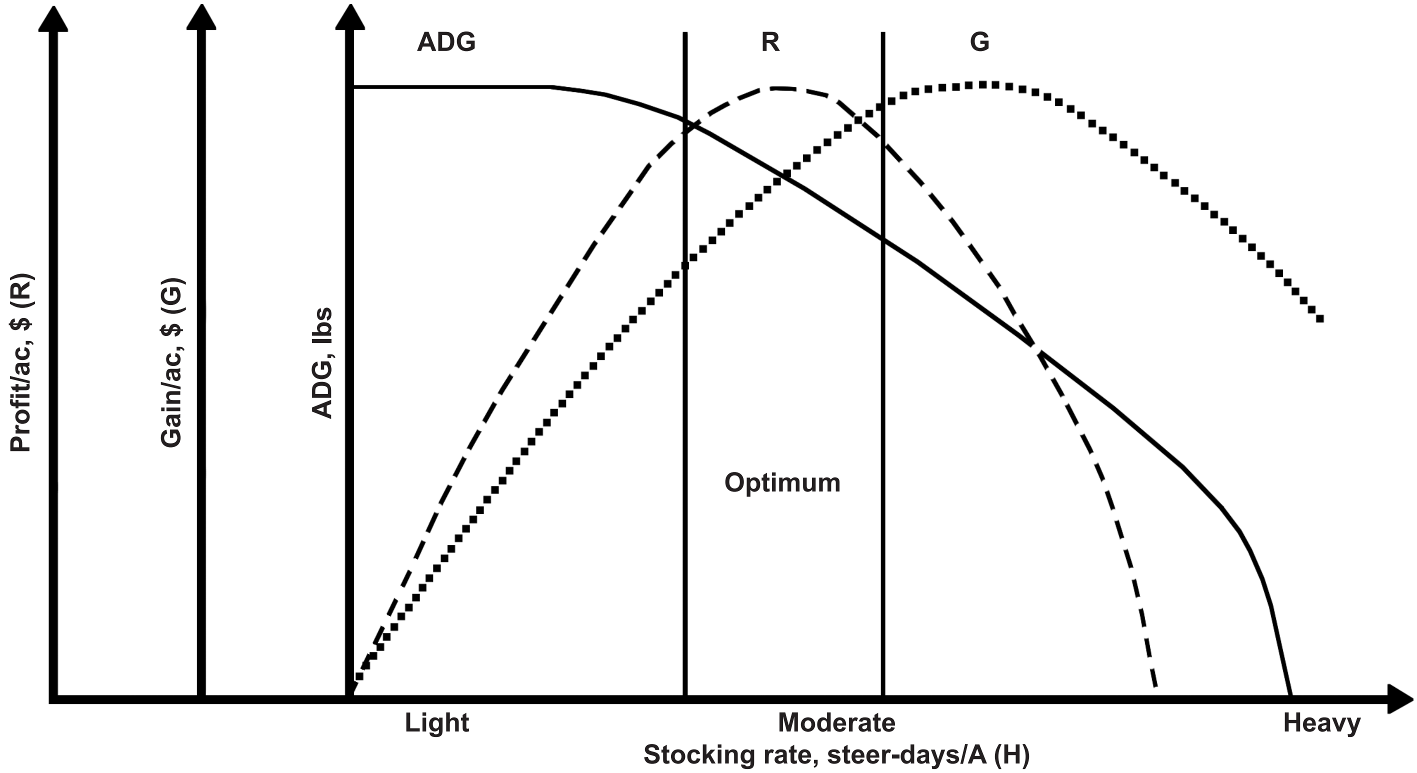


**Figure 36. Selecting a proper stocking rate is the most important decision when implementing patch burning. Some land managers believe that more is better, but research demonstrates that maximum net return per acre occurs at a moderate stocking rate.**

occurred there historically and are very adapted to fire and grazing at the proper stocking rate.

4. *Does patch burning require buffalo to work?*
   Granted bison are the symbolic native ungulate we think of concerning the fire-grazing interaction, but with the proper stocking rate patch burning has been shown to work very well with either stocker cattle or cow/calf enterprises. At this time there has been no work done with other domestic livestock such as goats or sheep. But with the proper stocking rate, these animals should fit very well into the patch-burning program.

5. *Can mowing be used effectively to replace grazing?*
   One of the values of grazing is that it is selective, and both bison and cattle select strongly for grasses. Mowing is nonselective so the effects on vegetation differ from the effects of grazing. If grazing is out of the question, mowing might partially replace the effects of grazing, but it is important to recognize that prairie evolved under the interacting influence of fire and grazing, not fire and mowing.

6. *What season and frequency of burning (fire-return-interval) is required in patch burning?* (Figure 35).
   This depends upon the goals and objectives of the land manager. Burning in two different seasons of the year will create more diversity. Fire frequency depends upon climate and rate of fuel accumulation. One approach is to determine the historic fire return interval for your area and use it as a starting point. If you have large accumulations of fuel and the most recently burned patch is not grazed heavily, increase fire frequency. On the other hand, if fuel loads are light and there is excessive grazing pressure on all of the patches, decrease fire frequency.

7. *What stocking rate of cattle is required for successful application of patch burning?*
   Stocking rate is generally expressed as animal units (cows, steers, etc.)/unit of land area/unit of time, while carrying capacity is the stocking rate that is sustainable over a long period of time. The main question should be, how well does your stocking rate agree with the carrying capacity of the land. Moderate stocking rate fits this description, and moderate stocking results in sufficient fuel to carry a fire.

8. *Will patch burning work on CRP, WRP, and introduced pasture grasses*?
   The full effects of patch burning will not be seen without grazing, but the use of patch burning in set-aside grasslands like CRP and WRP can help suppress woody plant encroachment,

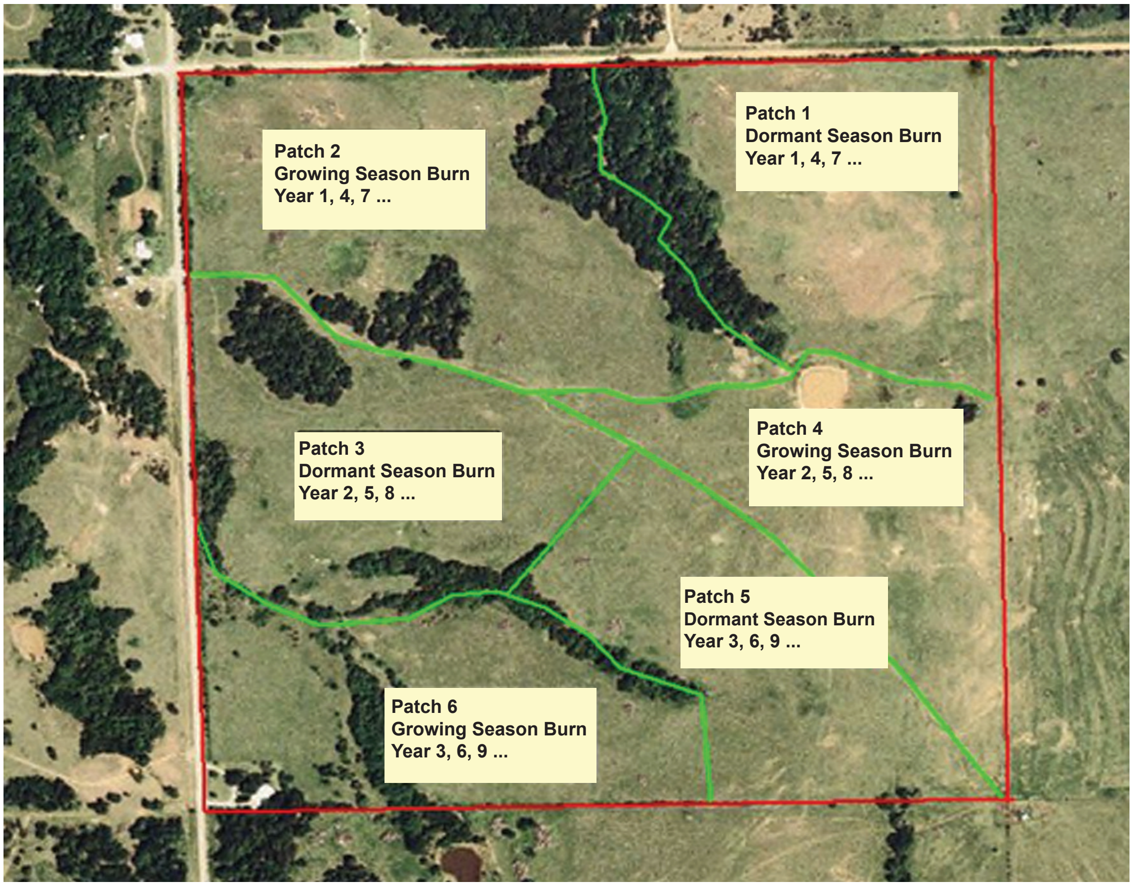


**Figure 37. An example of patch burning designed for a 3-year fire frequency and two burning seasons. This design uses existing pasture roads and creeks while minimizing construction of permanent lines for firebreakes.**

assist nutrient cycling, and create some diversity among plants and wildlife. If set-aside grasslands can be grazed, and WRP often allows grazing, patch burning should be effective. Introduced pastures are designed to be a monoculture, with managers working to keep them uniform with grazing systems, herbicides, and fertilizers. So trying to create heterogeneity in a homogenous system is counter intuitive. Still, using patch burning to create structural heterogeneity in these might have some value for some grassland wildlife species including songbirds.

9. *What size should the burn patches be*?
   This depends on your management objectives and logistical constraints. For example, if you were trying to maximize useable space for Northern Bobwhite, 100-acre patches would not be ideal. The home range of quail is normally smaller than this, and since quail require various vegetation structures within their home range, you would want to have smaller patches. Therefore, five 20-acre patches would be preferable. However, this size may not be logistically feasible depending on the landscape, topography, firebreak locations, equipment, and personnel available. A compromise might need to be met that will benefit the species managed for, but also be feasible for the land manager. Other species of wildlife will have different optimum patch sizes. If a land manager is trying to promote wildlife diversity, then various patch sizes might be most appropriate, assuming enough land is available.

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**Figure 38. Land managers have many questions about patch burning. These questions include season and frequency of burning (fire-return-interval) required in patch burning. The answer depends upon the goals and objectives of the land manager. Photo by John R. Weir.**


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## For more information about Patch Burning

www.fireecology.okstate.edu

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www.oaes.okstate.edu

Oklahoma Cooperative Extension Service
www.oaes.okstate.edu/extension

The Nature Conservancy
www.nature.org

Joint Fire Science Program
www.firescience.gov

USDA-Cooperative State Research, Education, and Extension Service
www.csrees.usda.gov/index

USDA-National Institute of Food and Agriculture
http://www.csrees.usda.gov/

Oklahoma Department of Wildlife Conservation
www.wildlifedepartment.com

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