The Response of Wildlife to Patch Burn Grazing

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Introduction

Patch burn grazing is a form of range management where fire is used to influence the distribution of grazing animals within a management unit such as a pasture (Weir et al. 2013). Many grazing animals, including bison and cattle, prefer to graze in recently burned areas because forage in those areas is typically of higher quality than forage in similar areas that haven't burned recently (Allred et al. 2011a). Patch burn grazing exploits the relationship between fire, forage quality, and grazing animal behavior to concentrate grazing activity in one area of a pasture, the area that has burned most recently, while simultaneously reducing grazing activity in other areas of the same pasture that haven't burned recently. Through time, a land manager conducts prescribed burns in different areas of the pasture, resulting in new areas being heavily grazed and other areas experiencing a rest from grazing activity as time passes from when they were last burned.

There are very few hard and fast rules dictating how patch burn grazing should be implemented by a land manager. Patch burn grazing systems have been characterized by pastures containing two (Allred et al. 2011a), three (Leis et al. 2013; Pillsbury et al. 2011; Rensink 2009; Winter et al. 2012; Winter et al. 2014), four (Augustine and Derner 2014; Limb et al. 2011), six (Fuhlendorf and Engle 2004), and eight (Allred et al. 2011a) patches. Some patch burn grazing systems have even been characterized by a number of patches that was not fixed, but varied through time based on the amount and location of fine fuels that were available to be burned within the pasture (Allred et al. 2011a; Hamilton 2007). Patch burn grazing systems have typically been characterized by a burn occurring within at least one patch of a pasture at least once each year. However, there have been instances where, following the burning of one patch in a pasture, the subsequent burning of another patch within the same pasture did not occur until two, three, or even four years later (Winter et al. 2012).

The number of patches within a pasture is often used to determine the fire return interval in the pasture, such that a two-patch system is characterized by a two-year fire return interval (i.e., each of two patches within the pasture is burned every other year (Allred et al. 2011a). Similarly, a four-patch system can be characterized by a four-year fire-return interval (i.e., each of four patches within a pasture is burned once every four years (Limb et al. 2011). However, the fire return interval at various locations within a single pasture has ranged from annual burning to a burn occurring approximately once every six years (Allred et al. 2011a; Hamilton 2007). Burns can be conducted within a patch burn grazing pasture during the spring (Leis et al. 2013; Pillsbury et al. 2011; Rensink 2009; Winter et al. 2012; Winter et al. 2014), summer

(Fuhlendorf and Engle 2004; Winter et al. 2013), fall (Augustine and Derner 2014; Vermeire et al. 2004), or winter (Allred et al. 2011b; Hamilton 2007), or even during multiple seasons within a single year (Allred et al. 2011b; Fuhlendorf and Engle 2004; Hamilton 2007; Vermeire et al. 2004). Finally, burns within a pasture can occur within well-defined management sub-units delineated by firebreaks that are essentially permanent (Fuhlendorf and Engle 2004; Rensink 2009), or they can occur in new areas every year where burn unit boundaries are determined by the availability of fine fuels (Hamilton 2007).

A number of patterns have emerged after a substantial amount of research on patch burn grazing. First, cattle performance or production tends to be similar when patch burn grazing is compared to other forms of rangeland or grazing management (Fuhlendorf and Engle 2004; Limb et al. 2011; Rensink 2009; Winter et al. 2014). In some instances, however, cattle performance has been demonstrated to be superior with patch burn grazing when compared to other forms of management (Augustine and Derner 2014; Limb et al. 2011). Second, vegetation structure (height, cover, visual obstruction) and species composition (grass/forb ratios) within pastures can differ when patch burn grazing is compared to other forms of management (Coppedge et al. 1998; Fuhlendorf and Engle 2004; Leis et al. 2013; McGranahan et al. 2012, 2013a; McGranahan et al. 2013b; Vermeire et al. 2004; Winter et al. 2012). Finally, the response of wildlife to patch burn grazing often differs markedly when compared to the response of wildlife to the effects of other forms of management (Churchwell et al. 2008; Coppedge et al. 2008; Doxon et al. 2011; Engle et al. 2008; Fuhlendorf et al. 2006; Fuhlendorf et al. 2010; Holcomb et al. 2014). The response of wildlife to patch burn grazing will be the focus of this paper and the accompanying presentation.

To date, wildlife response to patch burn grazing has been studied in a variety of locations across the Great Plains and Midwest. These locations include:

- Sand sagebrush mixed-grass prairie (Doxon et al. 2011; Holcomb et al. 2014) and tallgrass prairie (Churchwell et al. 2008; Coppedge et al. 2008; Engle et al. 2008; Fuhlendorf et al. 2006; Fuhlendorf et al. 2010; Hovick et al. 2014; Monroe and O'Connell 2014) in Oklahoma.
- Tallgrass prairie in Missouri (Debinski et al. 2011; Hovick and Miller 2013; Larson 2014; Moranz et al. 2012; Moranz et al. 2013; Moranz et al. 2014; Pillsbury et al. 2011; Stroppel 2009).
- Tallgrass prairie in Iowa (Debinski et al. 2011; Hovick and Miller 2013; Hovick et al. 2011; Hovick et al. 2012; Moranz et al. 2012; Moranz et al. 2013; Pillsbury et al. 2011).
- In Nebraska, research has been conducted in Sandhills mixed-grass prairie (Griebel et al. 1998), Platte Valley lowland tallgrass prairie (Anderson 2012; Biodrowski 2013), and upland tallgrass prairie in the southeastern portion of the state (Smith 2014).

Much of the research has focused on birds and invertebrates, but research has also been conducted on reptiles, amphibians, and small mammals.

The Response of Grassland Birds to Patch Burn Grazing

A disproportionate amount of research on the response of wildlife to patch burn grazing has focused on birds and there are likely a variety of explanations for this. First, grassland birds have consistently shown the greatest rates of decline relative to birds characterizing other habitats, so they are of heightened conservation interest (Brennan and Kuvlesky 2005). Second, bird use of grassland habitats is highly dependent on the vegetation structure that is present – height, density, cover, litter, bare ground (Fisher and Davis 2010), and grassland vegetation structure is readily affected by range management actions such as fire and grazing. Third, birds are readily observable and relatively easy to study.

Compared to some other traditional or conventional forms of rangeland management, patch burn grazing can create habitat conditions that are suitable for a wider variety of grassland bird species. For some species, suitable breeding habitat is characterized by relatively tall vegetation and a substantial amount of litter and residual growth from previous years. Conversely, other species require breeding habitat that is characterized by relatively short vegetation, little accumulated litter and residual growth, and a fair amount of bare ground. In tallgrass prairie of Oklahoma, a common form of rangeland management includes the annual burning of entire pastures, followed by stocking of yearling steers at twice the moderate stocking rate, but for approximately half the growing season. Pastures managed in this manner are characterized during the breeding season by relatively low vegetation heights, very little litter or residual vegetation, and a high amount of bare ground. Bird species that utilize this habitat during the breeding season include upland sandpiper, grasshopper sparrow, dickcissel, and eastern meadowlark, whereas Henslow's sparrows are typically absent from pastures characterized by this habitat (Coppedge et al. 2008; Fuhlendorf et al. 2006). Patch burn grazing pastures, though, provide habitat not only for the bird species that are found in the traditionally managed pastures (annual burning, double stocking), they also provide habitat for Henslow's sparrow. Within patch burn grazing pastures, Henslow's sparrows are found in patches that have not burned for two or three years and are experiencing very little grazing by cattle. Conversely, in the same patch burn grazing pastures, in patches that have burned most recently and are being heavily grazed by cattle, species such as upland sandpipers are relatively abundant because the habitat in those patches is what they prefer – short vegetation with little litter and high amounts of bare ground.

Similar results have been found for breeding birds in other areas such as sand sagebrush mixed-grass prairies of Oklahoma (Holcomb et al. 2014), tallgrass prairie of Missouri and Iowa (Pillsbury et al. 2011), and Sandhills mixed-grass prairie of Nebraska (Griebel et al. 1998). In all these instances, breeding bird communities in patch burn grazing pastures were distinct from those in adjacent pastures that were managed using traditional or conventional forms of rangeland management. With both types of management (patch burn grazing or traditional), the abundances of some species were highest in pastures managed one way while the abundances of other species were highest in pastures managed the other way.

A comparable effect of patch burn grazing on winter bird communities has also been documented, whereby patches of contrasting vegetation structure represent distinct habitats utilized by distinct winter bird communities (Hovick et al. 2014; Monroe and O'Connell 2014). Patches that had burned most recently during the previous growing season, and were characterized by short vegetation, very little litter, and high amounts of bare ground, had higher abundances of wintering species such as Smith's longspurs. Conversely, patches that had not burned in a recent growing season, and were characterized by taller vegetation, higher amounts of litter and residual vegetation, and less bare ground, had higher abundances of wintering species such as sedge wrens and Le Conte's sparrow.

Multiple variables associated with grassland bird nesting ecology have been compared between patch burn grazing pastures and pastures managed in other manners. In patch burn grazing pastures, dickcissel nest initiation occurred earlier in the year, parasitism by brown-headed cowbirds of dickcissel nests was lower, and dickcissel daily nest survival and overall nest success were higher when compared to the traditionally managed pastures (Churchwell et al. 2008). Nest parasitism of dickcissels in the most recently burned patches was higher than in the traditionally managed pastures, but no nest parasitism was documented in the other patch types (1-year and 2-year post-burn) of the patch burn grazing pastures. In another study (Hovick et al. 2012), daily nest survival rates of grasshopper sparrows were found to be higher in patch burn grazing pastures compared to pastures characterized by other forms of management.

Some grassland bird research has found little or no effect of patch burn grazing compared to other forms of rangeland management. For example, there was no difference in clutch size, the probability of nest parasitism by brown-headed cowbirds, and postfledging survival of grasshopper sparrows when patch burn grazing pastures were compared to pastures characterized by other forms of management (Hovick and Miller 2013; Hovick et al. 2011; Hovick et al. 2012). This lack of differences has been explained by the overriding effects of other factors such as land cover in the landscape surrounding the study pastures (Hovick and Miller 2013; Hovick et al. 2011; Pillsbury et al. 2011; Smith 2014).

The Response of Wildlife Other Than Birds to Patch Burn Grazing

The amount of research on invertebrate responses to patch burn grazing nearly rivals the amount of research conducted on birds. Invertebrate research has been conducted on whole invertebrate communities (Doxon et al. 2011; Engle et al. 2008), specific groups such as butterflies, leaf beetles and ants (Debinski et al. 2011; Moranz et al. 2012; Moranz et al. 2013; Moranz et al. 2014), and agronomic pest species (Polito et al. 2013; Scasta et al. 2012). In some instances, the effect of land use legacies (the previous history of fire, grazing, or cultivation) has been found to have a much greater influence on insect communities during a research period than the type of management, including patch burn grazing, that was applied during the study period (Debinski et al. 2011; Moranz et al. 2012; Moranz et al. 2013).

However, some research on invertebrates has generated similar results to what has been found with birds: insect communities within different patches of a patch burn grazing pasture can be distinct from one another, and insect communities within a patch burn pasture can be distinct from those present in adjacent pastures characterized by a different form of management (Doxon et al. 2011; Engle et al. 2008). Many of these effects may be related to how patch burn grazing affects vegetation, which in turn affects invertebrates. But the interaction of fire and grazing may also structure invertebrate communities in part by how it affects dominant invertebrates. The ant species *Formica montana* is often a dominant species in prairies managed with frequent fire, presumably because it is well adapted to fire as a disturbance. When fire is combined with livestock grazing, however, as in the case of patch burn grazing, *F. montana* is much less abundant and other ant species increase in abundance (Moranz et al. 2013). This suggests the interaction of two disturbances, fire and grazing, reduces the competitive effects of *F. montana* and allows other members of the ant community to experience a period of competitive release.

Some butterflies (and other invertebrates as well) are known to be sensitive to fire as a management technique because their life cycle includes stages when all individuals of a population may be vulnerable to direct mortality from a fire that occurs over the entire area they occupy, potentially killing every individual in that population (Moranz et al. 2014). Paradoxically, this can include species that are considered prairie specialists, that is, these species are restricted to a vegetation community that is dependent on fire (prairies) but they themselves are quite vulnerable to fire as a mortality factor. While patch burn grazing incorporates the use of fire, it does so in a patchy manner. Even though all individuals of a population may experience mortality in a recently burned patch of a patch burn grazing pasture, adjacent patches that have gone a longer period since being burned may be a source of recolonizing individuals. Additionally, the effects of patch burn grazing on vegetation may result in greater availability of floral resources that are important to some butterfly life cycle stages (Moranz et al. 2014).

Ticks and horn flies are two groups of agronomic pests that can negatively impact livestock performance and production, but these invertebrates could rightfully be considered wildlife as well. Two studies have demonstrated that patch burn grazing can be a useful tool in managing their populations. In the first study, horn fly abundance on cattle within patch burn grazing pastures was less than their abundance on cattle in pastures characterized by another form of management (Scasta et al. 2012). In the other study, cattle in patch burn grazing pastures carried a lower tick load than cattle from pastures characterized by another form of management (Polito et al. 2013). Both groups of invertebrates are susceptible to fire at specific portions of their life cycle when they reside in fecal pats or vegetation. Presumably, the most recently burned patch within a patch burn grazing pasture represents an area where populations of these pest species are lowest, relative to other areas of the landscape that haven't recently burned. Because cattle prefer to graze in recently burned patches, they end up spending a disproportionate amount of time in the portion of the landscape where these pests are least abundant.

The response of reptiles and amphibians in patch burn grazing pastures has been compared to their response in pastures managed only with patch burning (fire applied to separate patches within a pasture during successive years (Larson 2014). Aquatic amphibians occupying streams were not influenced by any of the treatments (patch burn grazing or patch burning), but were instead influenced by variables at the watershed scale (site) and by within-stream variables. There were distinct reptile communities, however, within distinct patches of both the patch burn grazing pastures and the patch burning patches. Finally, there are two studies that provide insight to the response of small mammals to patch burn grazing (Anderson 2012; Fuhlendorf et al. 2010). Like results reported previously for other taxa, both of these studies indicate that distinct patches within a patch burn grazing pasture are characterized by distinct small mammal communities, and this is likely the result of the distinct vegetation structure and composition within those patches.

Conclusions

The preponderance of evidence from the wildlife studies reviewed here indicates that patch burn grazing structures wildlife communities in a manner that is distinct from the way they are structured in areas characterized by other conventional or traditional forms of rangeland management. Patches within a patch burn grazing pasture represent different levels of the interaction between fire and grazing. In some patches of a patch burn grazing pasture, fire has occurred recently and grazing animal activity is high. In other patches within the same pasture, there has been a longer period of time since being burned and there is a corresponding lesser amount of grazing animal activity. The interaction of these disturbances, and the recovery from them, results in patches typically being characterized by distinct vegetation structure and composition, which translates into distinct wildlife communities.

As noted previously, there have been instances where no apparent response of wildlife to the implementation of patch burn grazing was found, such as when land use legacies can have an overriding effect. It can also occur when the scale at which patch burn grazing is implemented may be too small to have an effect that is relevant to the wildlife being studied. Research on birds that reported substantial effects of patch burn grazing was conducted in relatively large pastures (Coppedge et al. 2008; Fuhlendorf et al. 2006; Holcomb et al. 2014). This contrasts with other studies conducted in relatively small pastures that found less notable or no effects of patch burn grazing on birds (Pillsbury et al. 2011; Smith 2014). Though the response of prairie chickens to patch burn grazing has not been explicitly tested yet, they would presumably benefit from patch burn grazing because different portions of their yearly cycle require habitats characterized by distinct vegetation structure (McNew et al. 2012a; Mcnew et al. 2012b). However, this is also a species that would presumably need patch burn grazing to be applied at an appropriately large scale.

The utility of patch burn grazing as a means of manipulating wildlife habitats lies in its ability to generate habitats that are characterized by a wider array of vegetation compositional and

structural features, relative to other traditional forms of rangeland management. Traditional forms of rangeland management seek to apply disturbances such as fire and grazing in an even manner across management units (i.e., pastures) and have sought to maintain grazing animal activity at a moderate level. When entire landscapes are managed in this manner, the resulting habitat conditions are suitable for wildlife species that prefer those habitats. What's left out, though, are the habitats and associated wildlife species that are characteristic of greater amounts of both disturbance and rest. Traditional management might be thought of as "management for the middle," whereas patch burn grazing management might be thought of as "management for a broader array." Further research will help identify what species and communities would benefit from the implementation of patch burn grazing and under what circumstances those benefits may or may not be realized.

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