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Prescribed fire effects on resource selection by cattle in mesic sagebrush steppe. Part 1: Spring grazing☆

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ABSTRACT

Prescribed fire is commonly applied world-wide as a tool for enhancing habitats and altering resource-selection patterns of grazing animals. A scientific basis for this practice has been established in some ecosystems but its efficacy has not been rigorously evaluated on mesic sagebrush steppe. Beginning in 2003, resource-selection patterns of beef cows were investigated using global positioning system (GPS) collars for 2 years before and for 5 years after a fall prescribed burn was applied to mesic sagebrush steppe in the Owyhee Mountains of southwestern Idaho, USA. Resource-selection functions (RSF) developed from these data indicated cattle selected for lightly to moderately burned areas for all 5 postfire years. Cattle had been neutral towards these areas prior to the fire when their distribution was primarily affected by slope, sagebrush dominance, and distance to upland water. Resource-selection responses to the fire lasted 2–3 years longer than would be expected for fire-induced, forage-quality improvement effects. Although this is a case study and caution should be taken in extrapolating these results, if applied under conditions similar to this study, livestock producers and natural resource managers can likely use fall prescribed fire in the mesic sagebrush steppe to affect cattle resource-use patterns for 5 years postfire.

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1. Introduction

Prescribed fire is commonly applied to rangelands throughout the world as a tool for enhancing habitats and managing resource-selection patterns of grazing animals (Butz, 2009; Pyne, 1995; Wikeem and Strang, 1983). A scientific basis for this management practice has been established in montane grasslands, tall grass prairie, mixed prairie, shortgrass prairie, shrub steppe, and savanna (Augustine et al., 2010; Bates et al., 2009; Hobbs and Spowart, 1984; Klop et al., 2007; Peek et al., 1979; Vermeire et al., 2004). The sagebrush-steppe ecosystem occupies about 44.4 million ha in western North America. Higher elevation, mesic communities, dominated by mountain big sagebrush (*Artemisia tridentata* Nutt. ssp. *vaseyanna* Beetle) and/or antelope bitterbrush (*Purshia tridentata* [Pursh] DC), form a substantial proportion of the sagebrush steppe and serve as principal livestock grazing areas. Despite their prominence, use of prescribed fire for managing resource selection by livestock has never been rigorously evaluated on mesic sagebrush steppe rangelands.

Fire has always played an important ecological role, promoting heterogeneity on mesic sagebrush steppe rangelands. Prior to settlement, natural ignitions temporally converted areas of sagebrush-grassland to perennial grassland. Fire-killed sagebrush and bitterbrush eventually regrew, principally from seed, and returned the landscape back to sagebrush-grassland (Lesica et al., 2007). Fire also killed fire-sensitive, tree species like western juniper (*Juniperus occidentalis* Hook.) which tend to encroach into mesic sagebrush steppe (Miller and Rose, 1999).

Modern introductions of highly-flammable, exotic invasive plants like cheatgrass (*Bromus tectorum* L.) and medusa head (*Taeniatherum caput-medusae* [L.] Nevski) have increased fire frequencies in some areas and raised concerns about the modern role

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of fire in the sagebrush steppe (Whisenant, 1989; D'Antonio and Vitousek, 1992; Brooks et al., 2004; Pierson et al., 2011). However, while fire in the lower-elevation, more arid portions of the sagebrush steppe (e.g., Wyoming big sagebrush [*A. tridentata* Nutt. ssp. *wyomingensis* Beetle]-dominated communities) may cause severe degradation by converting sagebrush-grasslands into annual grasslands dominated by cheatgrass, type conversions of this nature are not inevitable (Davies et al., 2008) and are much less likely in the mesic sagebrush steppe where cheatgrass is less competitive with native perennial grasses (Chambers et al., 2007). In fact, within mesic sagebrush steppe, the concern is often about a modern lack of fire rather too much fire. Fire suppression or exclusion can lead to overmature, dense, excessively woody stands of mountain big sagebrush and antelope bitterbrush. Lack of fire can also promote encroachment of western juniper eventually resulting in a type conversion from sagebrush-grasslands to dense woodlands (Miller and Rose, 1999). Trees and shrubs can outcompete herbaceous plants for light, moisture, and soil nutrients (Wrobleski and Kauffman, 2003). Consequently, progression towards dense, overmature shrub stands or juniper woodlands can dramatically reduce the vigor, productivity, and availability of forage plant species important to rangeland livestock and wildlife (e.g., mule deer [*Odocoileus hemionus* Rafinesque]) (Miller et al., 2000). Prescribed fire is increasingly being applied by nature resource managers, to overmature stands of sagebrush or sagebrush stands suffering from tree encroachment, to carefully restart a fire cycle previously stalled by fire suppression. The intended purposes of these prescribed fires are often manifold but commonly fire is applied to improve livestock distribution.

Many factors affect livestock behavior and consequent resource-selection patterns (Bailey et al., 1996; Senft et al., 1987). Vegetation composition, cover, and forage characteristics affect use patterns of grazing animals (Bailey, 1995; Ganskopp and Bohnert, 2009; Ganskopp et al., 1992; Gillen et al., 1984; Howery et al., 1996). Water and mineral sources, topography, weather, and site microclimate also affect choice of foraging and resting areas, distance traveled between these focus areas, and time spent in them (Bailey, 1995; Bailey, 2005; Bailey et al., 2008; Cook, 1966; Howery et al., 1998; Loza et al., 1992; Mueggler, 1965; Senft et al., 1985). To be effective, livestock management treatments, including prescribed fire, must account for or work in concert with the most dominant of these environmental factors.

The intent of this research project was to evaluate spatial and temporal effects of prescribed fire on resource selection, activity budgets, and movement path characteristics of beef cattle in mesic sagebrush steppe rangelands. Two studies were carried out where, the first evaluated these cattle behavioral responses during spring (early May) just prior to peak forage production and, the second was conducted mid-summer (July) as forage plants began to senesce. The present paper presents findings from the first study. Two additional papers in this series present the findings from the mid-summer study and the results from cattle activity budget and movement path evaluations of both studies. Specific objectives of the spring grazing study were to: 1) model the resource-selection responses of cattle to prescribed fire and environmental factors; and 2) evaluate the efficacy of upland prescribed fire application for managing cattle distribution.

2. Methods

2.1. Study area

The study was conducted at the Whiskey Hill study area (324 ha), a fenced rangeland pasture within the Reynolds Creek Experimental Watershed (43° 9′ 49″ N, 116° 47′ 51″ W) located 80 km south of Boise in southwestern Idaho (Fig. 1). Climate is continental with maritime influences. Winters are cold and wet. Long-term (1962–2009) mean annual precipitation at the Whiskey Hill gauges (095 and 095b) was 453 mm (NWRC, 2010) with roughly 34% occurring as snow (Hanson, 2001). Annual precipitation during the study varied from a low of 186 mm in 2003 to a high of 600 mm in 2005 with amounts for all other study years being 8–67 mm less than the long-term mean. Summers are warm and dry. The growing season is about 100 days but frost can occur during any month of the year. Long-term (1967–2010) mean daily maximum, minimum and mean air temperatures at the nearby Lower Sheep Creek weather station (127 × 07) were 12.7, 3.8, and 8.3 °C, respectively (Hanson et al., 2001; NWRC, 2010). Mean daily air temperature varied during the study from a low of 8.6 °C in 2005, 2008, and 2009; 8.8 °C in 2004 and 2006; 9.4 °C in 2003, and to a high of 9.6 °C in 2007. Note that mean daily air temperatures for all study years were above the long-term mean.

Topography of the study area is a ridge with west and east-facing hillslopes and topped by granite outcrops. Elevation ranges from 1523 to 1878 m. Slope ranges from flat to very steep (177% or 60.5° maximum) with aspects in all four cardinal directions well represented. Soils are primarily derived from granitic parent materials and composed of a complex of Takeuchi (coarse, loamy, mixed, frigid Typic Haploxerolls) and Kanlee (fine, loamy, mixed, frigid Typic Argixerolls) soil series.

Three vegetation cover types; including mountain big sagebrush – mountain snowberry (*Symphoricarpos oreophilus* A. Gray), antelope bitterbrush – mountain big sagebrush, and native

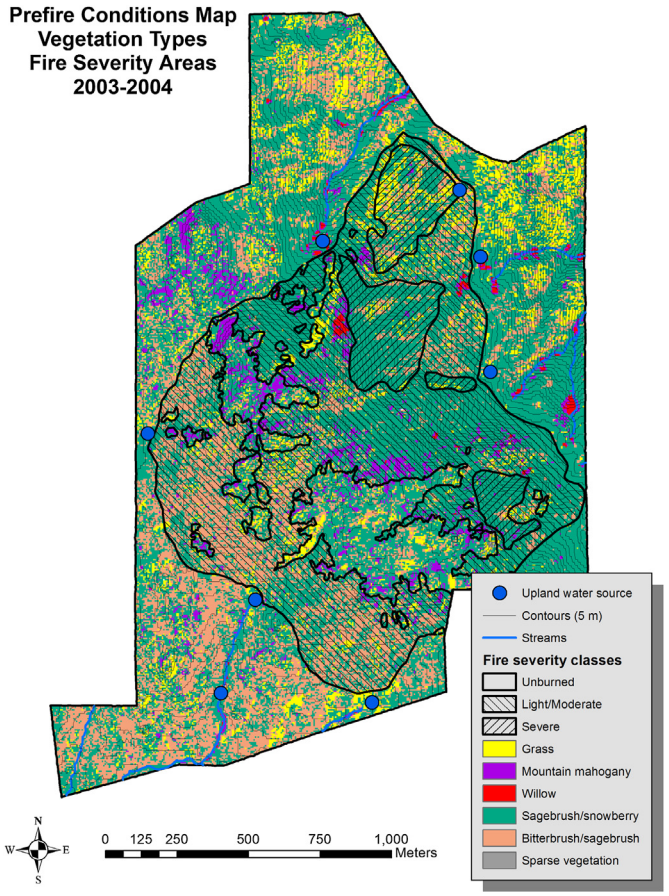

Fig. 1. Map illustrating the dominant prefire vegetation types and areas that later received different fire severity levels at the Whiskey Hill prescribed fire study area (324 ha) in the Owyhee Mountains of southwestern Idaho.