Canopy and Soil-Surface Fire Temperatures During Small-Plot Burns in a Saline-Greasewood Ecological Site

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Introduction
Fire is a common occurrence on western rangelands. In Wyoming, there are many areas with saline soils and warm-season grasses such as alkali sacaton (Sporobolus airoides), inland saltgrass (Distichlis spicata), and greasewood (Sarcobatus vermiculatus). The resprouting nature of greasewood combined with the ability of perennial grasses to respond to fire in general are preliminary indications that these ecological sites may be adapted to fire. But the role of fire in terms of frequency, intensity, and seasonality in saline-greasewood ecological sites is largely unknown, particularly in areas with greater herbaceous biomass production due to landscape position and subsurface water dynamics. In addition, the use of fire to control greasewood may reduce the shrub dominance and enhance forage.

Objectives
Our objectives were to quantify canopy and soil-surface fire temperatures during four small-plot burns in a saline-greasewood ecological site.

Materials and Methods
In spring 2017, undergraduate and graduate students in the University of Wyoming applied fire ecology course (REWM 4440/5440) conducted a field experiment using 10-foot-square burn boxes at the Laramie Research and Extension Center (LREC) west of Laramie (Fig. 1). To measure fire temperatures and create fire temperature profiles over time, we used two type K thermocouples and a Logitech recording device. Thermocouples were placed at two positions within the fuel complex: one at the soil surface and one within the plant canopies, 14 inches above the surface. Fires were conducted using a ring-fire technique by igniting one corner of the box and then carrying fire around all four sides until returning to the original ignition point. The ignition source was a drip torch with a mixture of 50% gasoline and 50% diesel. Fires were conducted within ‘safe’ weather conditions, with temperatures from 46 to 52°F, wind speeds from 3.3 to 10.3 miles per hour, and relative humidity from 21.6 to 26.2%. We first graphed fire temperature relative to time of the duration of the burn. We assessed the maximum temperature measured at each thermocouple and then calculated the difference between the two maximum temperatures at each thermocouple to determine delta ($\Delta T_{max}$).

Results and Discussion
Soil surface maximum temperatures ranged from 150°F to 511°F, with a mean of 316 ± 77°F. Canopy temperatures ranged from 238°F to 891°F, with a mean of 551 ± 138°F (Figs. 2a–d). $\Delta T_{max}$ ranged from 88°F to 638°F, with a mean of 236 ± 134°F. Thus, the temperature at the soil surface was <50% than it was within the fuel complex canopy. These fires were similar to low-fuel-load prescribed fires (~750°F; Weir and Scasta, 2014). Understanding potential maximum fire temperatures, and the difference between fire temperatures at the soil surface and the canopy of the fuel complex, is important for understanding plant and soil responses. Future studies could assess greasewood response to fire, and the use of fire as a feasible option to control greasewood without sacrificing forage and soil quality. It’s our plan to start these studies in 2019.

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Literature Cited

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Figure 1. UW students started fires in burn boxes to quantify canopy and soil-surface fire temperatures in a saline-greasewood ecological site in southeast Wyoming.

Figure 2. Fire weather and fire temperatures at two locations in the fuel complex for four (a–d) small-plot fires in a saline-greasewood complex. Notes: °F, MPH, and RH indicate air temperatures, wind speeds, and relative humidity, respectively; ‘top max’ and ‘bot max’ indicate maximum canopy and surface temperatures, respectively, during the fires; 35 cm = 14 inches; TSF = time since fire.