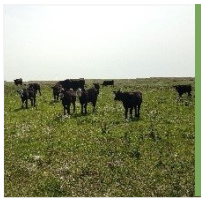

Manipulating Western Snowberry With Prescribed Burning to Promote Livestock Grazing

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Introduction

Woody encroachment threatens the structure, function, stability and productivity of rangelands by altering light quality (Peltzer and Konchy, 2001) and available nutrients and water to other herbaceous plant species. This causes variations in vegetation composition, and decreased plant species diversity, richness and overall forage productivity (Briggs et al., 2005; Limb et al., 2014; Van Auken, 2009).

Expansion of woody species is caused by changes in climate, increased atmospheric CO_2 (Archer, 1995), poor grazing management and lack of fire (Briggs et al., 2005). Absence of fire in the system has been the major cause of western snowberry or buckbrush (*Symphoricarpos occidentalis* Hook.) expansion in the Northern Great Plains.

Western snowberry is a native cool-season shrub with an early growing season and resprouting growth characteristics. This means that it can regrow easily following control methods such as mowing and fire. The use of herbicide is effective, but it can be cost-prohibitive and detrimental to other vegetation.

Grazing can be effective for herbaceous plant management, but it often is ineffective for woody plant control because low palatability reduces browsing (Briggs et al., 2002; Weber and Jeltsch, 2000). Manipulating forage quality characteristics can be an effective mechanism to encourage large grazing animals to consume undesirable species (Cummings et al., 2007).

Western snowberry regrowth that has been browsed, and one plant reaching flowering stage.

Forage quality characteristics include forage palatability, digestibility, nutrient content and intake, and are influenced by climate, season, plant characteristics, structure, maturity and disturbance (Renecker and Hudson, 1988). The structural and chemical makeup of a plant changes as it grows, with lignin, cellulose and fiber content in the plant cell increasing, while nutritive values and palatability decrease (Schindler et al., 2004).

Prescribed burning has been used to remove mature plant material and promote immature plant growth (Cook et al., 1994; Raynor et al., 2015; Anderson et al., 2007). Further, patch-burn systems allow for portions of a pasture to be burned, resulting in concentrated grazing in burned areas and changing the grazing selections from specific plant species to selection of the patch as a whole (Cummings et al., 2007). Limited evidence suggests that prescribed burning could promote the consumption of woody species regrowth by livestock (Debyle, 1989; Cook et al., 1994; Schindler et al., 2004).

The objectives of this study were to: 1) estimate the percentage of western snowberry that was browsed by cattle under early intensive, seasonlong and patch-burn grazing management and 2) create a timeline showing nutrient content of regrowth following a spring prescribed burn, mature shrubs one year post-burn and unburned mature shrubs.

Based on cattle grazing preferences and the effect of burning on plant structure and nutrient content, we hypothesized that cattle will graze western snowberry regrowth more readily following prescribed fire, compared with mature unburned western snowberry, due to an initial increase in palatability and nutritive content following the prescribed burn.

Procedures

Grazing treatments included seasonlong grazing, patch burn with seasonlong grazing, early intensive grazing and idle management (no grazing or burning), each replicated three times in 12 16-hectare (ha) (40-acre) pastures. Seasonlong and patch-burn pastures were stocked at 3.04 animal unit months (AUMs)/ hectare (1.23 AUMs/acre) and grazed May 1 to Sept. 5.

Patch burning began in 2014 on a four-year burn rotation in which one-fourth of each pasture was burned annually during the dormant season. Early intensive pastures were grazed at the same stocking rate but double the stocking density starting May 1, and cattle were removed after 1.2 months, approximately mid-June. This grazing management achieves similar grazing pressure as seasonlong and patch-burn grazing pastures by grazing more cattle for a shorter period of time.

Percent Browsed

To estimate western snowberry browsed per grazing treatment, we established four 100-meter (m) transects in each pasture and recorded the number of individual stems and browsed stems within a 1- by 1-m quadrat at 5-m intervals.

Nutrient content

Western snowberry samples taken for nutritional and digestibility analysis were clipped from idle pastures to represent unburned western snowberry, from patch-burn pastures the first growing season following burns and one-year post-burn at weekly intervals

from mid-May to mid-September. All samples were clipped to ground level, separated into old and new growth, and weighed wet and oven-dried.

The forage quality categories determined were: percent dry matter (DM), crude protein (CP), acid detergent lignin (ADL), acid detergent fiber (ADF), neutral detergent fiber (NDF), ash, calcium (Ca), phosphorus (P), in-vitro dry matter digestibility (IVDMD) and in-vitro organic matter digestibility (IVOMD).

Crude protein content represents the total nitrogen (N) in the feedstuff because CP is equal to N times 6.25 percent. Forage nutritive content of all samples was analyzed by the NDSU Animal Science Nutrition Lab.

Results

The percentage of western snowberry browsed (Figure 1) increased following the spring prescribed fire. Browsing occurred more within the patch-burn graze treatment (25.70 percent ± 6.71) than seasonlong (5.59 percent ± 1.54) and early intensive (8.32 percent ± 1.60) grazing treatments. The percentage browsed was not different between the seasonlong and early intensive grazing treatments. No browsing was detected within the idle treatment.

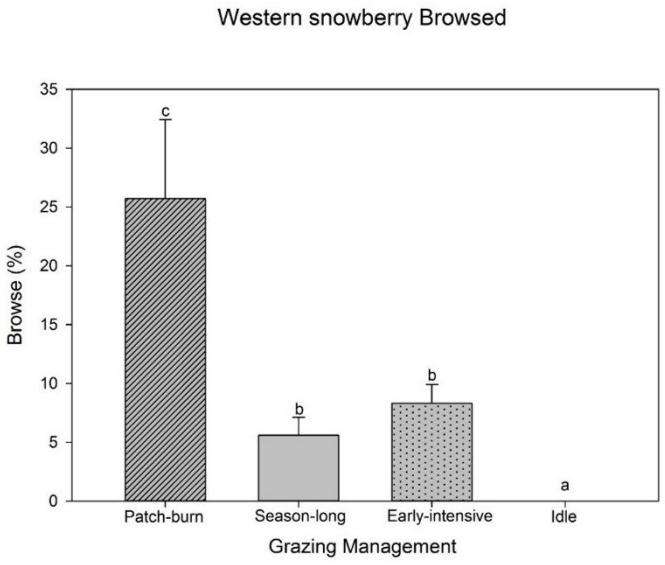

Figure 1. Percentage of western snowberry stems browsed within patch-burn and seasonlong grazing treatments and idle control at the CGREC in 2017.

The fibrous content (ADF and NDF) and acid detergent lignin (ADL) of western snowberry were different between old and new growth for the duration of the sampling period (Figure 2). The ADF content (Figure 2A) of 2017 post-burn regrowth (12.58 percent ± 1.86) and one-year post-burn new growth (15.24 percent ± 0.27) was lower than in nonburn new growth (18.22 percent ± 0.32) at three weeks post-burn.

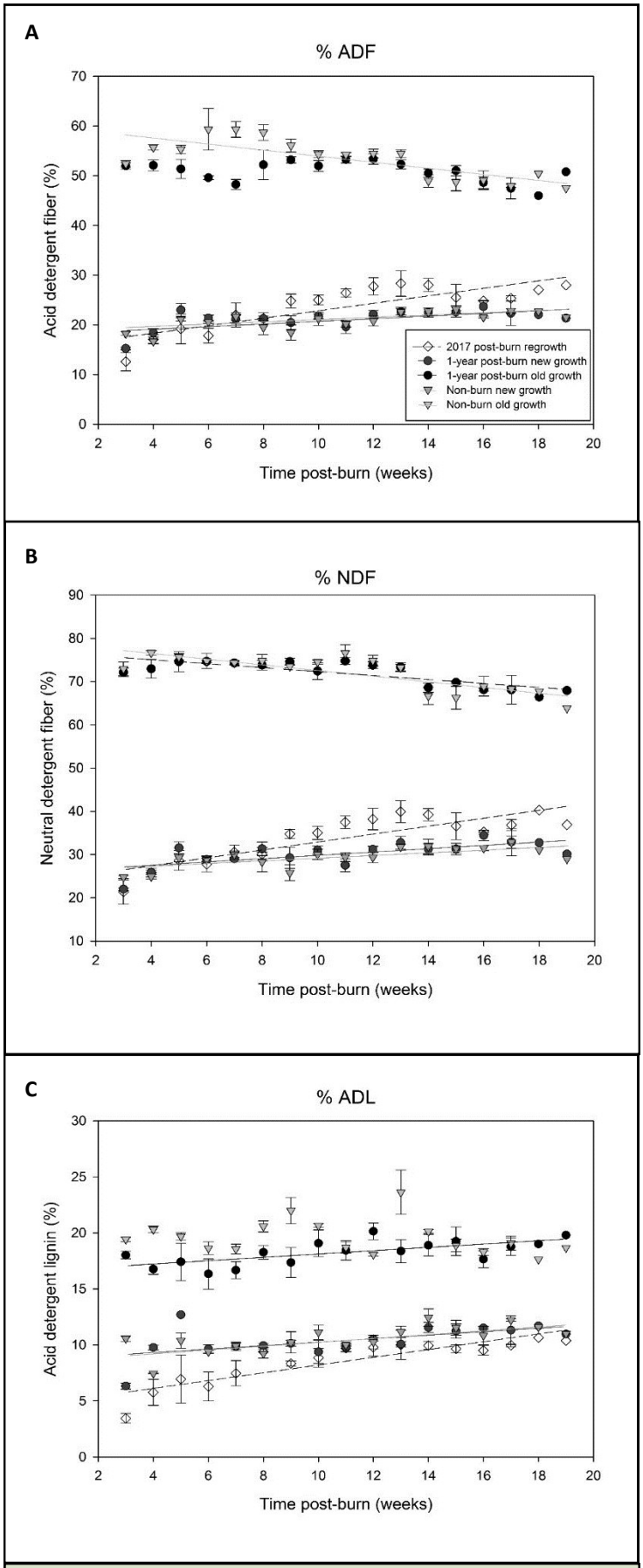

Figure 2. Acid detergent fiber, neutral detergent fiber and acid detergent lignin content of western snowberry for each treatment, with the sampling period starting once regrowth began following the 2017 spring prescribed burn at the CGREC. Lines indicate a significant regression.

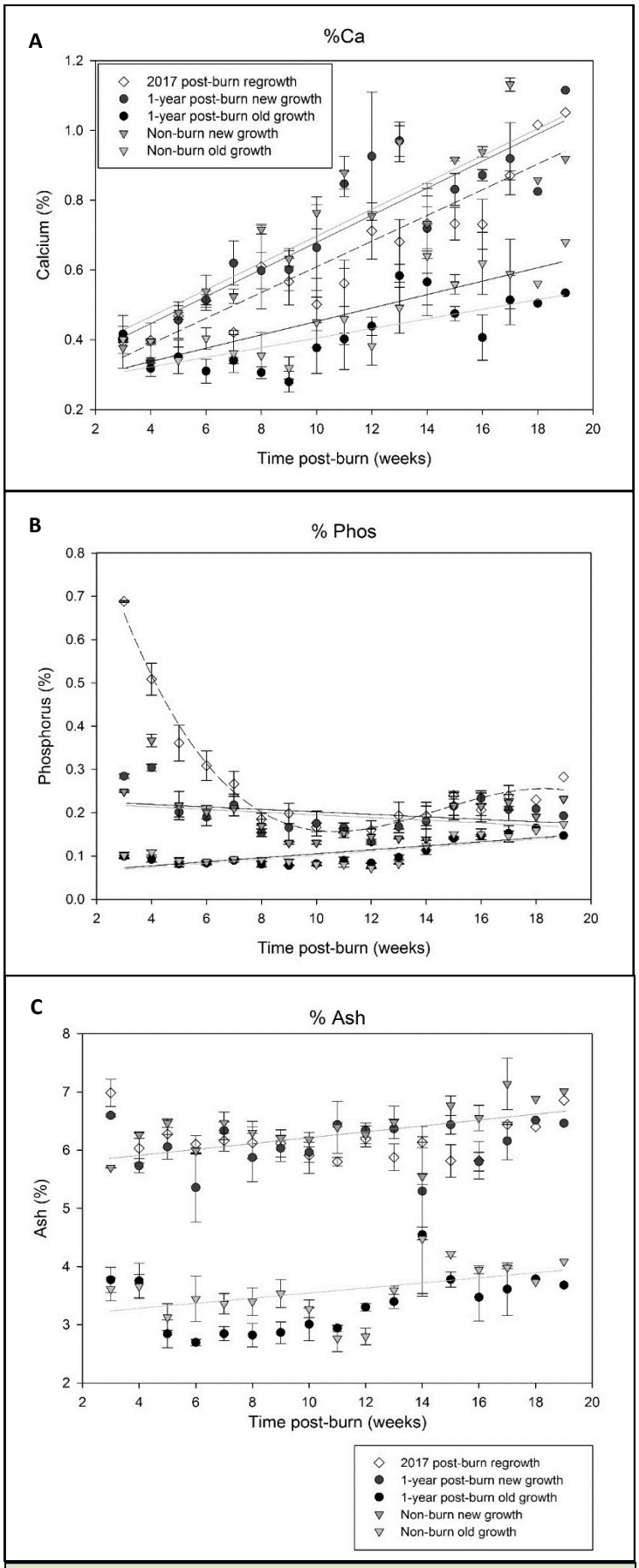

Figure 3. Calcium, phosphorus and ash content of western snowberry for each treatment, with the sampling period starting once regrowth began following the 2017 spring prescribed burn at the CGREC. Lines indicate a significant regression.

The NDF content (Figure 2B) of 2017 post-burn regrowth was higher than for the one-year post-burn and nonburn new growth at 11 through 14 weeks post-burn. The ADL content (Figure 2C) of 2017 post-burn regrowth (3.44 percent ± 0.44) was lower than for the one-year post-burn regrowth (6.32 percent ± 0.28) and nonburn new growth (10.56 percent ± 0.24) at three weeks post-burn.

The elements calcium (Ca) and phosphorus (P) changed inversely of each other through time (Figure 3). Calcium content of western snowberry increased within all growth types and treatments (Figure 3A). We found no consistent treatment differences, indicating a seasonal influence.

The P content (Figure 3B) of western snowberry 2017 post-burn regrowth was higher than it was one year post-burn and nonburn three through six weeks post-burn. The micro-mineral content (ash) of western snowberry 2017 post-burn regrowth (6.99 percent ± 0.23) and one-year post-burn new growth (6.44 percent ± 0.02) was higher than for nonburn new growth (5.74 percent ± 0.004) (Figure 3C).

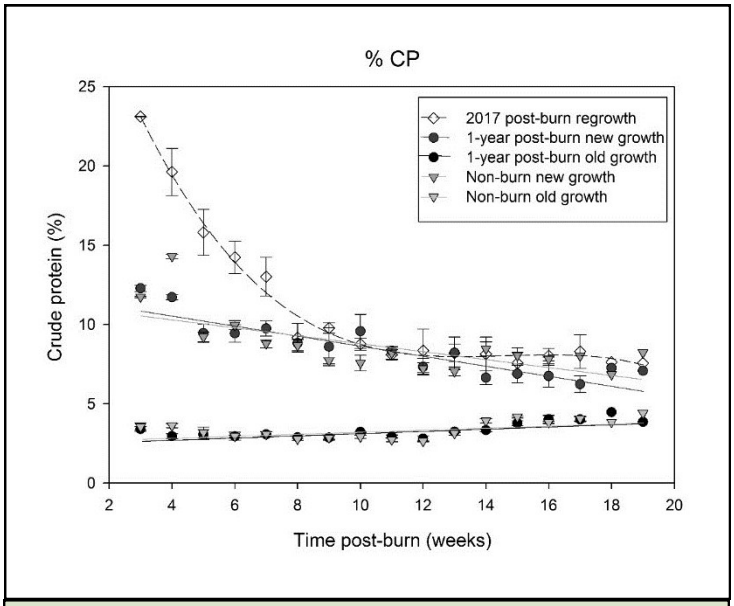

Figure 4. Crude protein of western snowberry for each treatment, with the sampling period starting once regrowth began following the 2017 spring prescribed burn at the CGREC. Lines indicate a significant regression.

The CP content of western snowberry new growth was higher than in old growth (Figure 4). The 2017 post-burn regrowth CP content was higher than for one-year post-burn and nonburn new growth from three through seven weeks post-burn.

The IVOMD and IVDMD of western snowberry (Figure 5; next page) was different between old and new growth for the duration of the sampling period. The IVOMD of 2017 post-burn regrowth (74.89 percent ± 1.55) (Figure 5A), one-year post-burn new growth (71.50 percent ± 0.10) and nonburn new growth (66.84 percent ± 0.22) all were different at three weeks post-burn.

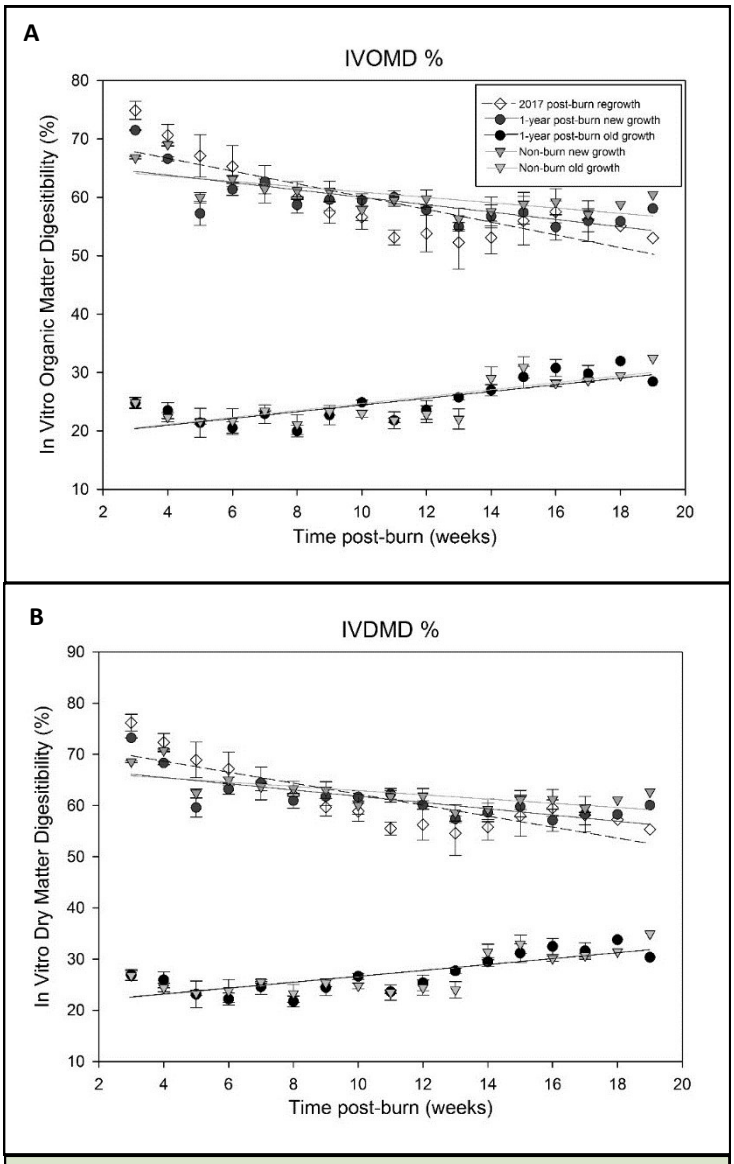

Figure 5. In vitro organic and dry-matter digestibility of western snowberry for each treatment, with the sampling period starting once regrowth began following the 2017 spring prescribed burn at the CGREC. Lines indicate a significant regression.

Discussion

Woody encroachment in grassland ecosystems results in alterations of rangeland plant community composition and productivity (Pelton, 1953; Archer, 1989). In a Northern Great Plains ecosystem invaded by western snowberry, we compared the percentage of shrub browsed by livestock under early intensive grazed, seasonlong grazed, patch-burn grazed and idle managements. Our study revealed that patch-burn grazing increased western snowberry browse three and five times greater, compared with browse in early intensive and seasonlong grazed pastures, respectively.

Fire removes mature plant material and debris, and effectively resets the growth cycle of vegetation, allowing new growth that is higher in palatability, nutrients and digestibility (Plumb and Dodd, 1993; Seastedt and Knapp, 1993; Cook et al., 1994; Anderson et al., 2007; Mbatha and Ward, 2010; Raynor et al., 2015). Our results and other research (Schindler et al., 2004; Saura-Mas and Lloret, 2009; Hejcman et al., 2016) suggest that a combination of changes in nutrient composition and concentrated grazing in the burned area (Cummings et al., 2007) contributed to the increased percentage of western snowberry browsed within the patch-burn graze management.

We found that as the shrubs matured, fibrous content increased and digestibility, crude protein and internal ash content decreased, regardless of treatment. Western snowberry new growth, including 2017 post-burn regrowth, was on average 30 and 41 percentage points lower in ADF and NDF content than old growth. This is consistent with traditional herbaceous forages; when ADF and NDF concentrations rise, the proportion of digestible plant tissue is reduced (Cook et al., 1994; Dufek et al., 2014; Raynor et al., 2015).

Crude protein of 2017 post-burn regrowth was 23 percent at three weeks post-burn and declined to 9 percent by eight weeks post-burn, at which point it was no different than for one-year post-burn and nonburn new growth, and the rate of decrease slowed. This same pattern of high crude protein with a rapid decline and leveling out approximately mid-way through the growing season has been seen for herbaceous vegetation as whole samples, and for other individual desirable and undesirable species (Defek et al., 2014; McGranahan et al., 2014).

The internal ash content of 2017 post-burn regrowth was 7.0 percent at four weeks post-burn; this is the average content of legume-grass forages (Platače and Adamovičs, 2014), and only slightly decreased with time post-burn. Internal ash is the total mineral content within a forage that would be present in hay or silage; it can be essential for meeting the dietary needs of livestock without supplementation, but at high levels, it may decrease feed intake.

Calcium and phosphorus, macro-minerals, change inversely of each other. Calcium increased, similarly to what has been documented for herbaceous forage species (Sinclair et al., 2006). Phosphorus content was highest in the 2017 post-burn regrowth until seven weeks post-burn, at which point it was not different than in other treatment new growth, closely following the same trend as crude protein.

Cow-calf pairs grazing in a burned patch.

Western snowberry regrowth

Four weeks post-burn

About ten weeks post-burn

One year post-burn

Photos by Haley Johnson, NDSU

Prescribed burning altered the growth cycle of western snowberry, ultimately making it utilizable as a forage for livestock consumption. It can be inferred that post-burn regrowth and new growth had a greater chance of being consumed instead of old growth due to higher palatability and digestibility.

Patch-burning altered the selectivity of cattle grazing preferences from plant-specific to patch-specific (Cummings et al., 2007). Increased crude protein, coupled with higher digestibility and palatability, following patch burning made western snowberry a desirable consumable within the patch; therefore, it was a contributor to grazing cattle diets.

Following a disturbance, livestock return to graze the area frequently due to higher nutrient content being prolonged during the growing season (Allred et al., 2011). Disturbances such as prescribed burning can be used to manipulate the structure of undesirable vegetation, promoting consumption by livestock and potentially aiding in control of the undesired species (Smart et al., 2007; Dufek et al., 2014).

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CGREC office

CGREC office and livestock unit