SRM Society for Range Management

An Assessment of Riparian Shrub Browsing

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On the Ground

- Browse estimates in this study were made using a random sampling strategy to monitor riparian shrub communities using presence or absence to determine the percent of shrub occupancy and intensity of browsing.
- This height-based shrub monitoring takes the guesswork out of complex browse estimates.
- The strategic timing of monitoring periods facilitates separation of wildlife and livestock browsing impacts.
- Height-based shrub monitoring was an efficient and repeatable method for tracking shrub occupancy, maturity, and shrub form.

Rangelands 41(3):145–148
doi 10.1016/j.rala.2019.03.001

A number of conflicts have developed between different disciplines regarding livestock grazing in riparian and stream ecosystems due in part to the use of varying objectives and monitoring techniques. Riparian tree and shrub ecology, fluvial geomorphology, and hydrology are often interconnected in the study of riparian environments.[1] With that in mind, studies in the field of geomorphology have typically taken into account the big picture of uplands containing riparian areas, and other disciplines remain focused on identifying influences of the near stream and streambanks on a site-specific level.

Management techniques can be put in place to address livestock grazing in selected riparian areas where browsing on woody vegetation is a concern once accurate monitoring methods provide information and direction for the management of shrub utilization. The primary objective of shrub monitoring is to guide land management toward the maintenance and improvement of shrub vigor, shading, recruitment, and growth.[2]

Several methods of monitoring shrub utilization rely on transects to estimate shrub form, age classes, measurement of leader growth, and removal of shrubs during the grazing season that are tagged for measurement pre- and post grazing.[3] Some methods require the observer to identify twig lengths through ocular estimates to serve as the foundation length for estimating the degree of browse use, which has limitations due to variation in use as well as observer bias.

Hall and Max[2] evaluated the difficulty of establishing repeatable estimates of leader growth and removal. They reported that estimates of shrub growth patterns (determinant vs. indeterminant) and environmental factors contributed to observer error, and the critical questions essential in assessing shrub browse impacts were generally left unanswered.

Keigley[4] noted that growth form assessment and shrub architecture could be used to describe browse condition over time. He suggested that repeated qualitative surveys of shrub community structure should be sufficient for the identification and management of browsing pressure. He indicated that protocols such as architecture-based surveys would enable land managers to assess the structure of a shrub community and compare differences in mature and young shrub components to gain an indication of the present and future condition of the shrub population if browse use does not change.

In 2011, Keigley and Frisina[5] described a refined height-based approach to shrub monitoring as an alternative to methods of twig length measurements. The height-based approach monitors the structural characteristics of the shrub community and the impact of browsing on shrub architecture. The objective of their height-based monitoring was to track the progress of shrubs reaching heights above the browse line.

The objective of this study was to use a random sampling strategy to monitor riparian shrub communities using shrub height, occupancy, and growth form.

Study Locations

Site Description

The study areas are located in eastern Oregon on the Snake River and the Blue Mountain Ecological Provinces.[6] The annual average precipitation of the Blue Mountain Province is 57 cm and the Snake River Province is 28 cm. Approximately 28% to 32% of the annual precipitation falls between April and July during the active growing season, and over half occur

between November and March. The elevation of the study areas ranged from 1,230 m to 1,500 m.

Each province encompasses a number of ecological sites that in practice can be described in terms of potential vegetation differences caused by local geology, geomorphology, and climate. The sites are located on the Wallowa Whitman National Forest in Baker County Oregon and are part of a cool forest comprised of Ponderosa pine (*Pinus ponderosa* Dougl.), Douglas-fir (*Pseudotsuga menziesii* [Mirbel] Franco), larch (*Larix occidentalis* Nutt.), and some grand fir (*Abies grandis* (Dougl.) with an understory of pinegrass (*Calamagrostis rubescens* Budkl.), elk sedge (*Carex geyeri* Boott), as well as shade-tolerant grass and forb species. The livestock grazing that occurs within the study area allotments is managed to protect the resources for wildlife and listed endangered fish species.

The shrub populations surveyed in this study occur as narrow, interrupted ribbons along geologically constrained tributary streams (B and C)[7] with channel widths of 1 m to 4 m and channel substrates consisting of cobbles, gravels, and smaller fragmented materials. Riparian and shrub populations within the mountainous regions of eastern Oregon often form a narrow interface that is 1 m to 2 m wide between aquatic and terrestrial ecosystems.[8] The shrub populations typically include the species of thinleaf alder (*Alnus incana* (L.) Moench), Douglas hawthorn (*Crataegus douglasi* Lindl.), black cottonwood (*Populus trichocarpa* T. & G.), yellow leaf willow (*Salix lutea* Nutt.), coyote willow (*Salix exigua* Nutt.), Pacific willow (*Salix lasiandra* Benth.), red-ozier dogwood (*Cornus stolonifera* Michx.), and aspen (*Populus tremuloides* Michx.).

Material and Methods

The study was conducted over a 3-year period in two different livestock-grazing allotments with two monitoring sites in each allotment. Each site was located at a permanent Forest Service key area-monitoring site with an established aggregate shrub browse standard of 20%.

The grazing allotments supported herd sizes of 300 to 400 cow–calf pair using a rest rotation pasture management with pasture grazing periods of 35 to 40 days. Within riparian areas, shrub browsing by livestock and wildlife are entangled and typical monitoring protocols lack the rigor to distinguish between ungulate uses. To address this issue, sampling objectives and methodologies need to partition, at least in part, the livestock browsing from wildlife browsing. In this study the timing of the sampling periods was used to partition browse use by sampling before livestock use and after livestock were rotated out of the units. While not a perfect partitioning, this approach separated periods of dominant livestock and dominant wildlife use.

Each sampling period was conducted using a random method of plot selection (random number generation of pacing distances in each sampling period) to place 1-m^2 plots at 100 random locations for the observation of shrubs.

Sampling was not restricted to the established Forest Service transects, but followed the stream riparian area until 100 plots were measured. Shrub occurrence (Table 1) within each plot was classified as shrubs present or absent, and shrubs mature (>150 cm) or shrubs immature (<150 cm). When shrubs were encountered that were <150 cm tall, browsing was observed within a "browse zone"[4] of 50 cm to 150 cm (Fig. 1). If the dominant leaders were not browsed the shrubs were documented as not browsed. If leaders were browsed but above an observed browse line it was documented as browsed with leaders above. If leaders were below an observed browse line it was documented as browsed. For shrubs to survive and grow to be >150 cm tall and out of reach of ungulate browsing it is assumed that the level of leader browsing will allow trees and shrubs to attain their normal stature.[4] Partitioning of this basic data set yielded information on the presence or absence of mature shrub (>150 cm), immature shrub (<150 cm), as well as information regarding browsing impact on shrub growth form.

Table 1. Summary of the shrub categories used to evaluate each plot

1. Shrub present OR shrub absent
2. Mature shrub >150 cm
Immature shrub <150 cm
3. Are there actively growing leaders above the browse line? OR Are the leaders below the browse line?

Browsing was defined as the removal of the woody stem tissue. The tips of twigs on a shrub browsed during the current or previous seasons established the browse line used to examine the shrub for leaders above the line. Removal of leaves was not documented as browsed.

A χ^2 analysis was performed to contrast differences among shrub community attributes and between browsed shrubs before livestock grazing and after grazing on each site. Annual and multiyear data sets provided the basis for tracking changes

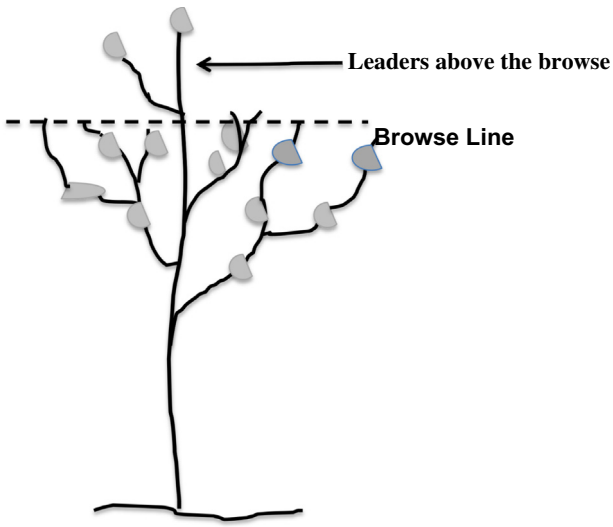

Figure 1. Illustration of a leader above the browse line on a browsed immature shrub (height < 150 cm).

Table 2. Percent change in shrub occupancy and mature size class during the 3-year study

Site	Shrub occupancy (%)	Change in mature size class (%)
	2015–2017	2015–2017
1	+16*†	+14†
2	+6 NS	-12‡
3	+15†	+4 NS
4	+19†	+4 NS

*Significance denoted within individual cells (†$P < 0.05$; ‡$P < 0.10$) for the time period 2015–2017.
NS indicates nonsignificance.

in the overall occurrence of the shrub population within the riparian area and the transition of individuals within those shrub populations from an immature to mature size class. The data set for each sampling period contained 100 1-m^2 plots. The data sets were analyzed to address the following questions: 1) Did shrub occurrence change during the study period? 2) Did the proportion of mature shrubs change during the monitoring period? 3) Did the amount of browsing change during periods of interest within the grazing season?

Assessment of Occupancy and Maturity

Multiyear data sets collected on four separate riparian areas (Table 2) were analyzed to detect changes in shrub occupancy and the transition of immature shrubs to the mature size class. On sites 1, 3, and 4, shrub occupancy increased 16%, 15%, and 19%, respectively, whereas shrub occupancy remained unchanged on site 2. These results suggest that the shrub populations on sites 1, 3, and 4 were undergoing a period of expansion toward their respective site potentials. By contrast, site 2, a site dominated by mature shrubs in 2015, was constant through the same time period and appeared to be at or near site potential.

Tests performed to detect changes in the mature size class within each shrub population describe size class changes that were taking place during the study (Table 2). Between 2015 and 2017, the mature size class was constant on sites 3 and 4, decreased on site 2 by 12% and increased on site 1 by 14%. These results indicate that while the shrub populations on sites 3 and 4 during the 3-year study period were increasing, the mature shrub population remained constant. We interpreted this result as an indication that site conditions during the study were favorable to immature shrub population recruitment. At site 1 the shrub population was undergoing both immature population recruitment and a significant transition within the shrub population from immature to mature size classes. Site 2 data reflected a period of stable shrub occupancy with a moderate decline ($P < 0.10$) in the mature shrub population. Results from this analysis demonstrate the interpretive value of presence or absence surveys to detect changes in occupancy and size classes within riparian shrub populations. Similarly, data sets could be analyzed to contrast shrub population attributes against site potential or other management objectives.

Table 3. Shrub population browsing impacts (%) over 3 years associated with periods of wildlife browsing alone and periods of livestock and wildlife browsing in common

Location and year	Browsing associated with wildlife	Browsing associated with livestock and wildlife
Site 1 2015	20 a	0 NS†
2016	35 b	0 NS
2017	31 b	−10 p = 0.10
Site 2 2015	32 a	4 NS
2016	36 ab	4 NS
2017	44 b	2 NS
Site 3 2015	23 a	3 NS
2016	27 a	2 NS
2017	27 a	2 NS
Site 4 2015	23 a	4 NS
2016	36 b	6 NS
2017	25 a	2 NS

NS indicates nonsignificance.
* Different column letters within sites 1 to 4 indicate significance $P < 0.05$.
† NS and $P < 0.10$ indicate annual significance of difference between browsing associated with wildlife and browsing associated with livestock and wildlife.

Assessment of Browsed Growth Form

Annual and multiyear comparisons of browsing data are provided in Table 3. The level of browsing that occurred across the years before livestock entered the study area varied among sites. Sites 1 and 2 showed increased wildlife browsing during the 3-year period. Site 3 wildlife browsing was relatively constant throughout the study, and site 4 initially increased and then declined the following year. These results illustrate that wildlife browsing during the winter, during the transition between winter and spring, and fall into winter periods varied between years. No particular pattern of use could be seen without additional information regarding environmental conditions and factors that influence wildlife occupancy.

Contrasting before and after data sets was used to provide an indication of the level of browsing that occurred when both livestock and wildlife had access to the shrub populations (Table 3). The majority of these comparisons (92%) showed no increase in the level of browsing during the active livestock-grazing period. These results suggest that the current livestock management strategy is not having a negative impact on shrub population structure and the browsing that occurred during this period was not removing leader growth below the browse line. Site 1 showed a decline in browsing during 2017, which reflected an extended period of favorable shrub leader growth. An insignificant number of plots were encountered throughout the study, which were categorized as browsed with leaders below (data not shown).

Management Implications

The objective of riparian shrub management within a livestock-grazing program is to ensure that livestock browsing does not become a limiting factor in shrub community development. Key elements of that assessment are to determine if shrubs can achieve their potential area of occupation and sustain a balanced population of immature to mature individuals under current management. This includes the promotion of a stem growth form that will allow steady growth in height.

Some natural resource scientists have stated that the greatest impact on small stream riparian areas comes from grazing by domestic livestock[9] and recommend livestock elimination through various management approaches. Johnson et al.[10] conducted a 5-year study tracking GPS (5-minute recording interval) collared cows across four allotments in northeast Oregon. They observed that livestock presence in riparian areas varied substantially with somewhat frequent use occurring on some perennial streams and little or no use occurring on others. Overall, cattle occupancy within 30 m and 60 m of streams was 1% to 2% and 1% to 4%, respectively. They also observed that livestock had preferred access points along streams and found that large percentages (75–95%) of the length of streams had minimal (<2 hr/y) occupancy by livestock. In other words, stream access and occupancy by livestock was selective, being influenced by multiple factors such as obstacles (topography, shrubs and brush, steep banks), trailing patterns, and off-site water. Furthermore, established pathways from favorite grazing areas to streams, roadways, and jeep trails that parallel the stream affected cattle travel routes within the allotments and influenced where cattle could water along the stream.

In this study a random sampling design combined with shrub height, occupancy, and growth form was sufficiently robust to detect increases in the area of total shrub populations, as well as transitions of immature shrubs to maturity. The method did not focus on an arbitrary amount of browse use based on twig lengths, but rather on the most critical aspect of browsing, which is an intensity of browse to a shrub when height growth is halted and shrub mortality is increased. The few protocols associated with a height-based assessment enhanced monitoring efficiency. As a general rule, ocular observations that are limited to binary questions will limit the opportunity for personal bias when compared with complex estimates of perceived leader growth and removal. This browse monitoring technique allows management objective to be established and tested based on shrub population attributes related to the status of the vegetation management.

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Additional Reading

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