

Vegetative Characteristics of Oak Savannas in the Southwestern United States: A Comparative Analysis With Oak Woodlands in the Region

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Abstract—Much has been learned about the oak woodlands of the Southwestern United States in recent years. However, comparable characterizations of the companion oak savannas are needed to help in enhancing the knowledge of all oak ecosystems in the Madrean Archipelago region. Oak savannas differ from oak woodlands in that they are more open in their structure with fewer trees and, as a consequence, a higher level of herbaceous production might be expected. Species compositions and densities of tree overstories and production of herbaceous understories in representative oak savannas are presented in this paper with comparisons of these characterizations to the more densely stocked oak woodlands. Differences observed in the two oak ecosystems suggest that they should not necessarily be considered homogeneous “management units” in terms of their tree overstory characteristics or other natural resources values linked to the characteristics of tree overstories.

Introduction

Much has been learned about the oak woodlands—also referred to as encinal woodlands, from the Spanish word *encinal* meaning wholly or mostly oak—of the Southwestern United States in recent years. Ecological, hydrologic, and environmental characterizations have been obtained through collaborative efforts involving a large number of people. This state-of-knowledge has been presented in a variety of publications and presentations (DeBano and others 1995; Ffolliott 1999, 2002; McClaran and McPherson 1999; McPherson 1992, 1997; and others). Comparable characterizations of the companion oak savannas are needed to enhance the knowledge of all of the oak ecosystems in the Madrean Archipelago region. Oak savannas differ from oak woodlands in that they are more open in their structure with fewer trees, and, as a consequence, a higher level of herbaceous production might be expected. Species compositions and densities of tree overstories, as well as production of herbaceous understories in representative oak savannas and more densely stocked oak woodlands, are presented in this paper.

Description of Study

Study Areas

Twelve small watersheds established in the oak savannas on the eastern side of the Peloncillo Mountains of southwestern New Mexico to evaluate the impacts of cool and warm season prescribed burning treatments on hydrologic and ecological

characteristics of the watersheds (Gottfried and others 2000) were collectively one study area. The areal aggregation of these watersheds, called the Cascabel watersheds, is 451.3 acres. The watersheds are situated between 5,380 and 5,590 feet in elevation and the nearest long-term precipitation station indicates that annual precipitation averages 23.5 inches with nearly one-half occurring in the summer. General geological, physiological, and vegetative characteristics of the Cascabel watersheds have been described by Gottfried and others (2000) and, therefore, will not be presented here.

The study areas in the oak woodlands were located at about 5,740 feet in elevation on the southern slopes of the Huachuca Mountains along the United States-Mexico border. Average annual precipitation in the general area is 21.6 inches, again, nearly equally split between the summer and winter. Published (Touchan 1988; Gottfried and Ffolliott 2002; Ffolliott and others 2003) and unpublished inventory data from this area have been used to characterize the tree overstories and herbaceous understories in these oak woodland communities.

Study Protocol

On each of the 12 Cascabel watersheds, between 35 and 45 sample points were located along transects perpendicular to the main stream system and situated from ridge to ridge. Intervals between the sample plots varied among the watersheds depending on the size and configuration of the watershed sampled. A total of 421 sample points were located on the watersheds. Measurements of tree overstory conditions and estimates of herbaceous production were obtained on plots centered over these sample points. Species compositions and densities of

the tree overstories were measured on 1/4-acre circular plots. Single-stemmed trees were measured in terms of their diameter root collar (drc) and multiple-stemmed trees in equivalent diameter root collar (edrc) following the procedures outlined by Chojnacky (1988). Densities of the trees were expressed in stems per acre. Production (standing biomass) of grasses, forbs, and shrubs in the herbaceous understories were estimated on 9.6-square-foot plots. These components of herbage production were estimated by weight-estimate procedures (Pechanec and Pickford 1937) in the spring (early growers) and fall (late growers).

Study protocols on the southern slopes of the Huachuca Mountains (Touchan 1988; Gottfried and Ffolliott 2002; Ffolliott and others 2003) were different than those on the Cascabel watersheds. Species compositions and densities of tree overstories were tallied (in separate inventories but in the same time period) on 80 1/10-acre and 23 1/4-acre circular plots randomly located circular plots. Herbage production (biomass) was estimated by weight-estimate procedures on 100 systematically located 9.6-square-foot plots in the falls of 1985 and 1986.

Results and Discussion

Tree Overstories

Tree species found on the Cascabel watersheds and the southern slope of the Huachuca Mountains are largely the same. The dominant species tallied include Emory (*Quercus emoryi*) (60.1% of all trees tallied), Arizona white (*Q. arizonica*) (11.9%), Toumey oak (*Q. toumeyii*) (4.4%), and alligator juniper (*Juniperus deppeana*) (15.3%). Minor components of the tree overstories are redberry juniper (*J. coahuilensis*) (2.0%), pinyon (*Pinus cembroides*) (5.6%), and mesquite (*Prosopis velutina*) (0.7%). Species of trees commonly observed in inventories of the oak woodlands on the southern slopes of the Huachuca Mountains were dominantly Emory (89.3%) oak with intermingling Arizona white (8.7%) oak and a few scattered alligator juniper (1.3%) and pinyon (0.7%).

Total densities of tree species tallied on the respective study sites are shown by size-classes in figure 1. The size-classes shown in this figure coincide with the categories listed by O'Brien (2002) for the woodland types of Arizona; that is, saplings (1.0 to 4.9 inches drc), medium trees (5.0 to 8.9 inches drc), and large trees (9.0 inches drc and larger). The overall test of significance for all size-classes (all trees) was evaluated at the 0.10 level. However, because the three size-classes are nested within the overall test, a Bonferroni adjustment was applied to maintain the Type I error in a test of significance for the size-classes at a 0.30 level. The densities of medium and large trees on the Cascabel watersheds were significantly less than the corresponding densities of the tree overstories in the southern slopes of the Huachuca Mountains, while the densities of saplings on the two areas were statistically similar.

The relative variability of the spatial distributions of tree overstories on the Cascabel watersheds (coefficient of variation = 7.98) is greater than that observed for the trees tallied on the southern slopes of the Huachuca Mountains (coefficient

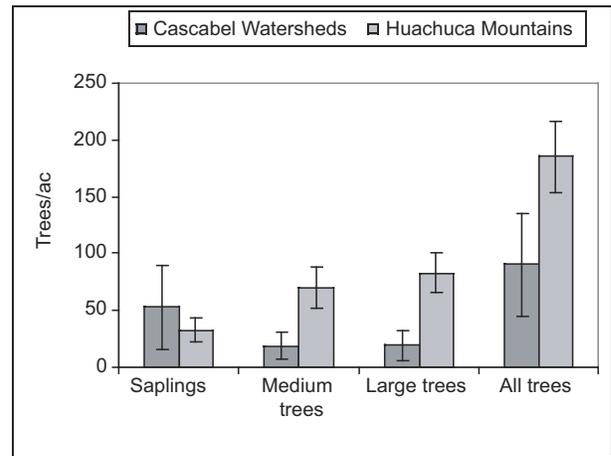


Figure 1—Average densities and 90% confidence intervals of tree overstories in the oak savannas on the Cascabel watersheds and the oak woodlands on the southern slopes of the Huachuca Mountains.

of variation = 1.08), suggesting more heterogenous stocking conditions in the oak savannas than in the oak woodlands. (This possibility must be “conditioned” by the fact that there were different sample designs and sampling intensities on the two study sites.) Openings of varying size, shape, and orientation interspersed among the tree overstories throughout the oak savannas on the Cascabel watersheds are less common in the oak woodlands on the southern slopes of the Huachuca Mountains in the oak woodlands.

Herbaceous Understories

Herbaceous species observed on the Cascabel watersheds and the southern slopes of the Huachuca Mountains (Gottfried and Ffolliott 2002) are largely similar. Included among the more commonly encountered grasses are blue (*Bouteloua gracilis*), sideoats (*B. curtipendula*), slender (*B. filiformis*), and hairy (*B. hirsuta*) grama, bull muhly (*Muhlenbergia emersleyi*), wolftail (*Lycurus pheoides*), and Texas bluestem (*Schizachrium cirratum*). Forbs are a minor herbaceous component on both sites with minimal occurrences of Fendler ceanothus (*Ceanothus fendleri*) and Mexican cliffrose (*Purshia mexicana*) present. Beargrass (*Nolina microcarpa*), fairy-duster (*Calliandra eriophylla*), and sotol (*Dasyliirion wheeleri*) are scattered shrubs.

Spring and fall production of grasses, forbs, and shrubs on the Cascabel watersheds for the one year (2003) of estimation is presented in table 1. This was a year of below average precipitation. Total herbaceous production in the oak woodlands on the southern slopes of the Huachuca Mountains was estimated for two falls in an earlier study (Gottfried and Ffolliott 2002). Herbage production averaged 345 lbs/acre, varying from almost 400 lbs/ac in 1985, a year of nearly average summer precipitation, to 290 lbs/ac in 1986, a year of below average summer precipitation.

Fall production of herbaceous plants in the southern slopes of the Huachuca Mountains in both years of estimation was greater than the fall estimate of herbage production on the

Table 1—Means and standard errors for the production of herbaceous plants on the Cascabel watersheds for 2003.

Plant group	Spring	Fall
	-----lbs/ac-----	
Grasses	201.5 ± 7.6	147.5 ± 6.2
Forbs	4.9 ± 0.8	6.0 ± 0.9
Shrubs	26.3 ± 6.4	41.2 ± 4.2
Total	232.7 ± 14.4	194.8 ± 11.3

Cascabel watersheds in 2003. However, comparison of herbage production is problematic, because the estimates were not obtained in the same years. Variability in the amount and seasonal distribution of precipitation in the Southwestern United States limits comparison of herbage production when limited data are available; this was the case here. Estimates of herbage production need to be made for a sufficient number of similar years to adequately reflect the variability that precipitation might have on herbage production to make comparisons. Furthermore, the year that herbage production was estimated on Cascabel (2003) was the sixth year of a drought in the region, and, it is assumed, that the herbage estimates obtained reflected these conditions.

A comparison of the frequently observed relationship of increasing herbage production with decreasing tree overstories densities (Ffolliott and Clary 1982) has been made, although this comparison is tentative because of the lack of long-term herbage estimates. There was little relationship (no significant correlation) between spring or fall herbage production and tree overstory densities on the Cascabel watersheds for the year of estimate. A lack of understory-overstory in the oak woodlands of the Huachuca Mountains relationship has also been reported (Gottfried and Ffolliott 2002). It is suggested, therefore, that tree overstory densities might not be a significant factor in “controlling” the production of herbaceous plants in oak ecosystems. This possibility is strengthened by a finding that there was little relationship between annual herbage production and tree overstory densities in the Gambel oak (*Q. gambelii*) stands that were intermingled with the ponderosa pine (*Pinus ponderosa*) forests on the Beaver Creek watersheds in northern Arizona (Reynolds and others 1970).

While the dominantly oak overstories in the savannas on the Cascabel watersheds and the oak woodlands on southern slopes of the Huachuca Mountains do not appear to affect herbage production, the reverse situation might not be true. McClaran and McPherson (1999) reported that a dense perennial grass cover can limit successful Emory oak regeneration on ungrazed sites. However, further study is necessary to verify this situation.

Conclusions

This study shows that there are differences in the tree overstories characterizing the oak savannas on the Cascabel watersheds and the oak woodlands on the southern slopes of the Huachuca Mountains. Tree overstories in the oak savannas are less dense (more open) and stocking conditions appear

more heterogenous than in the oak woodlands. Assuming that this finding might reflect the more general case, it is possible that these two ecosystems (which are both are found within the Upper Encinal Type (Turner and others 1003) and classified in the *Quercus emoryi/Bouteloua curtipendula* (Emory oak/sideoats grama) habitat type) should not be considered homogeneous “management units” in terms of their tree overstory characteristics or other natural resources values linked to the characteristics of tree overstories such as wildlife habitats. More extensive study is necessary to verify this possibility.

It is premature to draw conclusions about herbage production in the two oak ecosystems. Comparative differences in herbage production can only be determined by obtaining same-year estimates of herbage production in the two ecosystems for a period of time. This is long enough to reflect the precipitation variability.

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