

A Comparison of Understory Species at Three Densities in a Pinyon-Juniper Woodland

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Abstract—The relationship between pinyon-juniper density and associated understory were examined at three sites at Pigeon Hollow north of Ephraim, UT. Historically the study site was grazed from the turn of the century to the 1980's when Utah Division of Wildlife Resources acquired the land. The area has since been used as critical winter range for wildlife with little livestock grazing, except for some trespass. All sites were north facing with 4 percent slope. Tree canopy cover was compared across three tree densities. Frequency and percent cover were reported across a gradient of pinyon-juniper densities. As pinyon-juniper tree density increases, associated understory and interspace herbaceous percent cover and diversity decreases. Decrease of perennial grasses amid tree interspaces was as significant as beneath tree canopy.

The pinyon-juniper forest complex is an important component of the vegetation of the Intermountain West. This forest complex is mainly comprised of two leaf pinyon pine (*Pinus edulis* [Engelm.]), Utah juniper (*Juniperus osteosperma* [Torr.]), one seed juniper (*Juniperus monosperma* [Engelm.]), and Rocky Mountain juniper (*Juniperus scopulorum* [Sarg.]). This community complex provides the majority wintering range for big game and associated animals in Utah (Stevens and Walker 1996). The pinyon-juniper woodlands comprise nearly 25 million ha (62 million acres) throughout the western United States (West 1986). Since settlement of the Great Basin, pinyon-juniper has expanded its range from steeper mountain slopes to alluvial fans and steppes. Increase of pinyon-juniper is primarily due to suppression of fires and overgrazing by livestock during the last 100 to 150 years. Cottam (1961) reported western Utah's pinyon-juniper woodlands were among the most heavily impacted by domestic livestock during the period following settlement in the 1800's. The increased acreage of pinyon-juniper has led to problems in watershed management, loss of big game habitat, and reduced plant diversity. As the trees obtain dominance the remaining understory is

severely reduced (Dye and others 1995). Pinyon-juniper trees influence other plants in several ways: shading, litter accumulation under the tree canopy, interception and retention of rainfall by the branches and by the root system in the interspaces, and the development of an extensive, shallow, competitive root system (Schott and Pieper 1985). Junipers have a large lateral root system that extends well beyond the crown (Jameson 1967). The influence of individual trees on soil chemical properties has been demonstrated by many studies (Follet 1969; Garcia-Moya and Mckell 1970; Tiedemann and Klemmedson 1973; Zinke 1962).

Arnold and others (1964) found conclusive reductions in the basal cover of grasses and forbs with the increase of canopy cover. Previous studies reveal a vast difference in herbaceous composition directly below the tree canopy and within the interspaces among trees (Armentrout and Pieper 1988; Schott and Pieper 1985). The objective of this study was to determine if tree density and tree canopy cover influenced the composition and presence of understory species. The question then arises, if tree density is decreased through management will the understory become more diverse and percent ground cover increase? Also, at what tree density can one expect to meet management objectives for forage availability? Understanding this relationship with tree density and understory herbaceous composition will aid in management of pinyon-juniper woodlands.

Study Site

The Pigeon Hollow study area is located in Sanpete County, Utah, approximately 8 km (5 miles) north of Ephraim (S 12, T 16, R 3). The elevation of the area ranges from 1,700 m (5,575 ft) to 1,900 m (6,235 ft). The average yearly precipitation is 321 mm, (12.6 inches) falling mostly during October and December. The average temperature ranges from 7.2 to 8.8 °C (45 to 47 °F). Soils at Pigeon Hollow are excessively drained, gently sloping to very steep gravelly sandy loams that are 25.4 to 50.8 cm (10 to 20 inches) deep over limestone. Soils formed in colluvium, local alluvium, and residuum are derived from limestone on hillsides and ridges. They are of the Amtoft Series, most commonly associated with Sanpete and Sigurd soils (USDA, SCS, USDI, and BLM 1981). The Pigeon hollow area is owned by the Utah Division of Wildlife Resources and is managed as a wintering ground for wildlife. Habitat is provided for mule deer (*Odocoileus hemionus* [Rafinesque]) and Rocky Mountain elk (*Cervus elaphus nelsoni* [Bailey]), allowing both shelter and forage during the winter. All study sites

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are located on north aspects with slopes of 4 to 5 percent. This area has not been grazed by livestock for 15 years except for periodic grazing by sheep.

The prevalent grass species are: bluebunch wheatgrass (*Pseudoroegneria spicata* [Pursh]), Sandberg bluegrass (*Poa secunda* [Presl.]), cheatgrass (*Bromus tectorum*), Indian ricegrass (*Achnatherum hymenoides* [Roem & Schult]), Needle-and-thread grass (*Hesperostipa* [Trin. Rupr.] Barkw.), and bottlebrush squirreltail (*Elymus elymoides* [Raf.] Swezey). The shrub component includes: big sagebrush (*Artemisia tridentata* [Nutt.]), narrowleaf low rabbitbrush (*Chrysothamnus viscidiflorus* [Hook]), winterfat (*Ceratoides lanata* [Pursh]), shadscale (*Atriplex confertifolia* [Torr. & Frem.]), and broom snakeweed (*Gutierrezia sarothrae* [Pursh]). Major forbs are: Hoods phlox (*Phlox hoodii* [Richards]), burr buttercup (*Ranunculus testiculatus* [Crantz]), aster species, and various annual mustards. Utah juniper, Two leaf, and pinyon pine are the main tree components.

Methods

Three north facing slopes were chosen for sampling. Pinyon-juniper tree density decreased from east to west on each slope relating to the advancing front of a pinyon-juniper population. To sample different tree densities, each slope was divided into three tree density categories: high, moderate, and low. The assigned title to the categories does not necessarily represent exact or fixed densities but are high, moderate, and low, relative to one another. A 40 m² site was sampled within each tree density category on each slope. All pinyon and juniper trees were counted in each 40 m² site to establish tree density. In addition, five stratified random points were selected in each plot for sampling herbaceous plant composition and tree canopy cover. A modified quarter method was used at each of these five points. In each cardinal quarter the distance to the nearest tree was measured and the species of tree identified. The quarter method and tree number counts were used at each site to calculate and verify tree density. Trees were classed into seedling, juvenile, adult, or decadent. Two 0.25 m² nested frequency frames were placed along the line connecting the sampling point and the nearest tree. One quadrat frame was placed under the tree canopy and another was placed in the tree interspace. The understory sample frame was placed midway between the trunk and canopy edge of each tree sampled. The interspace quadrat frame was placed within the nearest interspace along a line connecting the sampling point and the nearest tree trunk. To qualify as an interspace there could be no tree canopy cover within 2 m of the quadrat frame. Nested frequency data and eight cover points were recorded for each sample. Data were collected from 20 frames under the tree canopy and 25 frames in the interspace at each site. Summed frequency values were used to compare understory and interspace species. Smith and others (1987) have shown summed frequency values to be useful in comparing vegetation differences. A soil penetrometer was used at each sampling point to determine soil depth. Data were subject to analysis of variance using the General Linear Model (Ott 1984). Significant differences at $p < 0.05$ among means were determined using Student-Newman-Kuels multiple range test on all main effect means.

Results And Discussion

Previous studies have demonstrated that as tree density increases understory decreases (Arnold and others 1964; Barney and Frishnecht 1974). In this study three categories of tree density were sampled to determine understory and interspace herbaceous composition at varying pinyon-juniper densities. The high and moderate tree densities contained 885 trees per ha (357 trees per acre) and 714 trees per ha (289 trees per acre). The low tree density contained 394 trees per ha (159 trees per acre). The low tree density was significantly different from the moderate and high tree densities but moderate and high tree densities did not vary significantly from each other. A wider range of densities would have been helpful to separate moderate and high values. For this report high tree density will be compared to low tree density to examine the relationship between the undercanopy and interspace herbaceous composition.

Four species consistently appeared in the sampling. The species included bluebunch wheatgrass, Sandberg bluegrass, cheatgrass and bur buttercup. These species are associated with pinyon juniper communities and serve as indicators of community health. Everett and Koniak (1981) found Sandberg bluegrass to be the most consistent perennial grass component in the understory of pinyon-juniper community, and cheatgrass was a common annual grass component. Figures 1, 2, and 3 report significant differences among understory and interspace frequency values for these species.

Fewer species were encountered in the interspaces than in the understory. A total of 18 species were encountered in the understory while only 12 species appeared in the

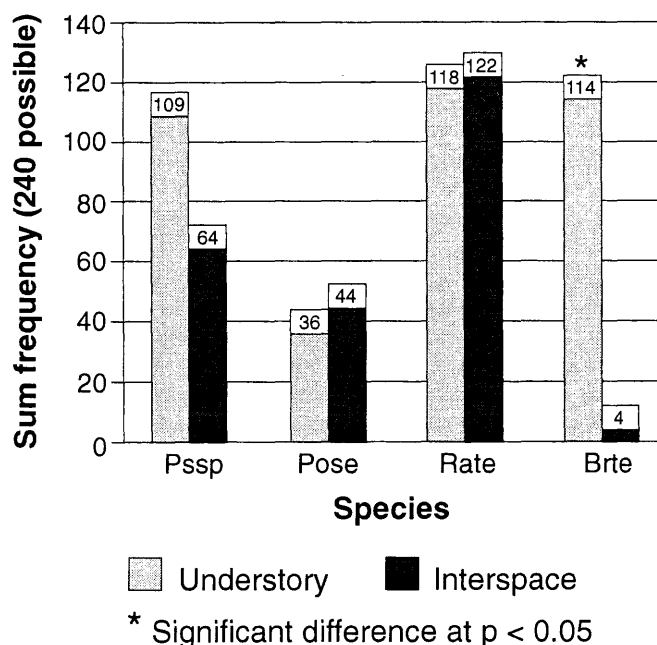


Figure 1—Sum frequency at high tree density for bluebunch wheatgrass (Pssp), Sandberg bluegrass (Pose), bur buttercup (Rate), and cheatgrass (Brte).

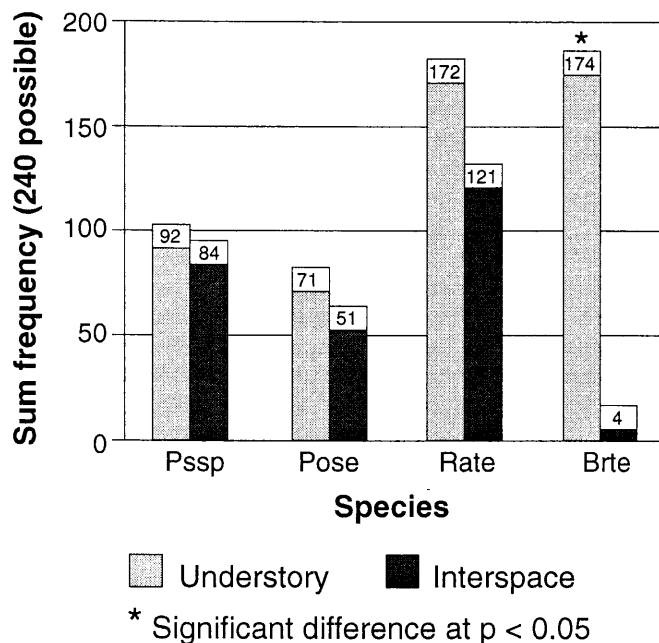


Figure 2—Sum frequency at moderate tree density for bluebunch wheatgrass (Pssp), Sandberg bluegrass (Pose), bur buttercup (Rate), and cheatgrass (Brte).

interspace. Fewer annual species were recorded in the interspace than in the understory.

At all tree densities, cheatgrass sum frequency values were significantly greater in the understory compared to the interspaces. At low tree density cheatgrass did not appear in the interspace but was limited entirely to the juniper understory. These findings are similar to reports of Everett and Koniaks (1981). Where cheatgrass is present it is closely associated with juniper canopy understory.

Sandberg bluegrass had significantly higher sum frequency values in the understory of the low tree density than in the interspace (fig. 3). At the high tree density there was no difference between understory frequency and interspace frequency. The interspace was small enough and influenced by the tree density that herbaceous composition did not vary under the canopy or in the interspace. Sum frequency values were less for higher tree density indicating that as tree density increases Sandberg bluegrass decreases. There was less bur buttercup in the understory and interspace of the low tree density than the high tree density although not significantly less.

Mean height of each juniper in the highest tree density area was 2.5 m. In the lowest tree density areas mean height was 3.01 m. Trees in the lowest tree density were 17 percent taller than those in the highest tree density areas. A decrease in average tree height may indicate competition for available resources among trees in the high density. Correlating with a decrease of tree height with increased tree density was a decrease in mean canopy cover by each individual tree as density increased. The mean canopy cover for the high density was 3.6 m² as compared to 6.4 m² for the low density. Canopy cover was 47 percent less per individual tree in the high tree density compared to the low

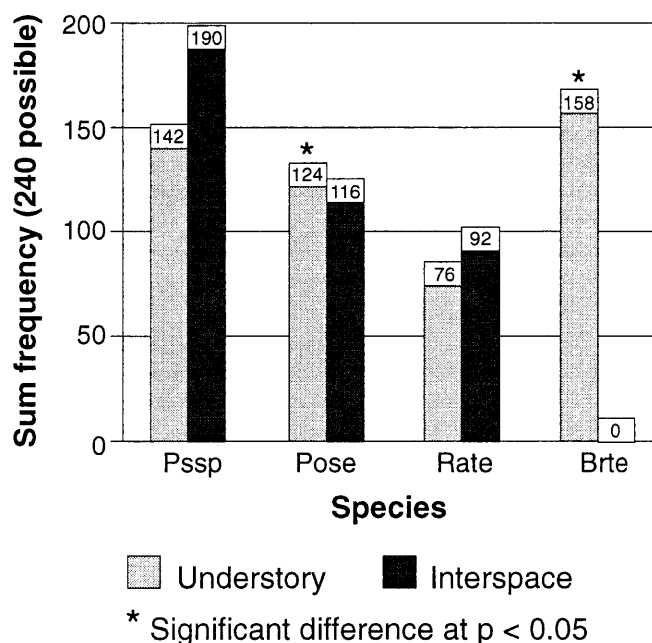


Figure 3—Sum frequency at low tree density for bluebunch wheatgrass (Pssp), Sandberg bluegrass (Pose), bur buttercup (Rate), and cheatgrass (Brte).

tree density. The tree density significantly effected the tree size. The greater the tree density the smaller canopy cover of each tree.

The data support the relationship of pinyon-juniper density to understory. In this sampling, as tree density increased understory and interspace herbaceous composition became less desirable and canopy cover declined. Considering this relationship very dense stands of pinyon-juniper woodlands are likely candidates for tree removal if management objectives warrant such an action. Low density pinyon-juniper woodlands can be more diverse and productive than very dense forest.

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