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Some Quantitative Aspects of the Present Shrub Community in Ginkgo State Park, Washington

The specific aim of the study reported here is to describe, through quantitative analysis, patterns and trends reflected by the major shrub species found occurring in the shrub community of Ginkgo State Park, Washington. The study area is located in the southeast corner of Kittitas County in central Washington on the west bank of the Columbia River. The park area includes approximately 7,000 acres.

General criteria for site selection were established before field work was begun. Among the criteria used, minimum disturbance was a key factor. Sites were also selected to represent topographic aspects in the lower and upper elevations of the park, and data were analyzed to provide information relative to the frequency, density, and cover of the major woody species as influenced by physiographic aspects. A brief reconnaissance of the area was conducted before data were recorded, including a preliminary survey of the principal species, physiognomy, general soil conditions, and land use. Field data were collected during the spring of 1967 and the fall of 1968 by use of the line strip method of sampling (Lindsey, 1955).

Taxonomic nomenclature follows Hitchcock, et al (1964) for all species.

Climate

Information covering a 30-year period from 1930 at the Ellensburg weather station (Phillips, 1965), located about 30 miles west of the state park, indicates regional temperatures of minus 18C or above 38C occur infrequently. On a typical winter day, the average afternoon temperatures range from 1C to 4.5C and the night time temperatures from minus 12.3C to 6.5C. The average summer afternoon temperature is in the high 20's and the night temperature lies between 10 and 15C. Maximum temperatures reach the mid or upper 30's on a few days during July and August.

The annual precipitation in this area during the 30-year period has averaged nine inches (Phillips, 1965). From the latter half of November through February, most of the precipitation increases in the fall, reaching a peak of slightly more than one inch each month in the winter, then gradually decreases in the spring with an increase in May and June followed by a sharp drop near mid-summer. Phillips (1965) indicates that July through September is the driest part of the year with an average of .40 inch precipitation over the 30-year period.

Methods

Twenty sites were established after a general reconnaissance of the study area was completed. These sites represent an elevational gradient from 700 feet (213m) through 1,650 feet (503m) as well as slope exposures typical of the study area. Of the 20 sites surveyed, 11 were located in the lower elevations of the park, while the remaining nine represent north-south slope aspect as well as rolling topography in the upper elevations.

The line-strip was established using a distant topographic feature as a guide to the direction of travel across a site. Each line-strip, separated by 100 feet, was 50 feet long and 10 feet wide, or 500 square feet in area. A total of 290 line-strips were completely tallied in the park.

Plant cover was determined where the plant crown, measured to the nearest half-foot, intercepted the 50 foot tape and was defined as the amount of ground covered by a projection of the crown of the plant in a vertical plane. Frequency (the percentage of plots in which a given species occurred) and density (the number of individuals of a species per unit area) were also measured.

These data were converted into relative values for each site and an Importance Value (Curtis and McIntosh, 1951) was determined for each perennial species by adding the relative values. Since relative values of frequency, density, and cover each total 100 for any given site, the total Importance Value possible for any given species is 300. The index thus derived serves as a good indication of the ecological importance of a species within a stand and may be used as a comparative tool in the analysis of large samples of vegetation.

The Importance Values of each of the major species in this study were compared on the basis of elevation and topographic aspect (Table 1). Plant densities in the

TABLE 1. Importance Values of the major woody shrub species as influenced by topography in the lower (l) and higher (h) elevations in Ginkgo State Park, Washington.

Major shrub species	Plains		N-slope		S-slope		ALL STANDS	
	L	H	L	H	L	H	L	H
<i>Artemisia arbuscula</i>	47	118	59	93	34	118	45	109
<i>Artemisia tridentata</i>	113	18	141	150	78	5	110	56
<i>Astragalus inflexus</i>	—	10	—	—	—	12	—	8
<i>Chrysothamnus nauseosus</i>	9	—	11	1	2	—	9	1
<i>Eriogonum microthecum</i>	43	—	12	—	68	—	42	—
<i>Eriogonum sphaerocephalum</i>	28	9	23	21	12	26	24	17
<i>Eriogonum strictum</i>	24	1	42	3	59	27	39	9
<i>Eriogonum thymoides</i>	2	90	1	18	12	31	4	54
<i>Pediocactus simpsonii</i>	—	8	—	2	—	—	—	3
<i>Phlox hoodii</i>	general distribution, increasing in the higher elevations							
<i>Phlox kelseyii</i>	14	33	2	12	—	39	6	27
<i>Salvia dorrii</i>	13	15	9	1	26	42	16	18

shrub community were also calculated on an acre basis and compared from an elevational and topographical standpoint (Table 2).

Species groupings are further identified when Behavior Indices are calculated (frequency x relative cover) (Burgess, 1965) and plotted against elevation and slope aspect (Figs. 1 and 2). This method provides an indication of those major shrub species which tend to increase or decrease in importance relative to slope aspect and elevation within the park.

TABLE 2. Plant density of the major shrub species in Ginkgo State Park, Washington. Figures are on an acre basis.

Stand aspect	Dominant shrub density per acre	
	low elevations	high elevations
Plains to rolling land	3804	7118
North facing slopes	3324	2758
South facing slopes	4173	3497
Average	3767	4458

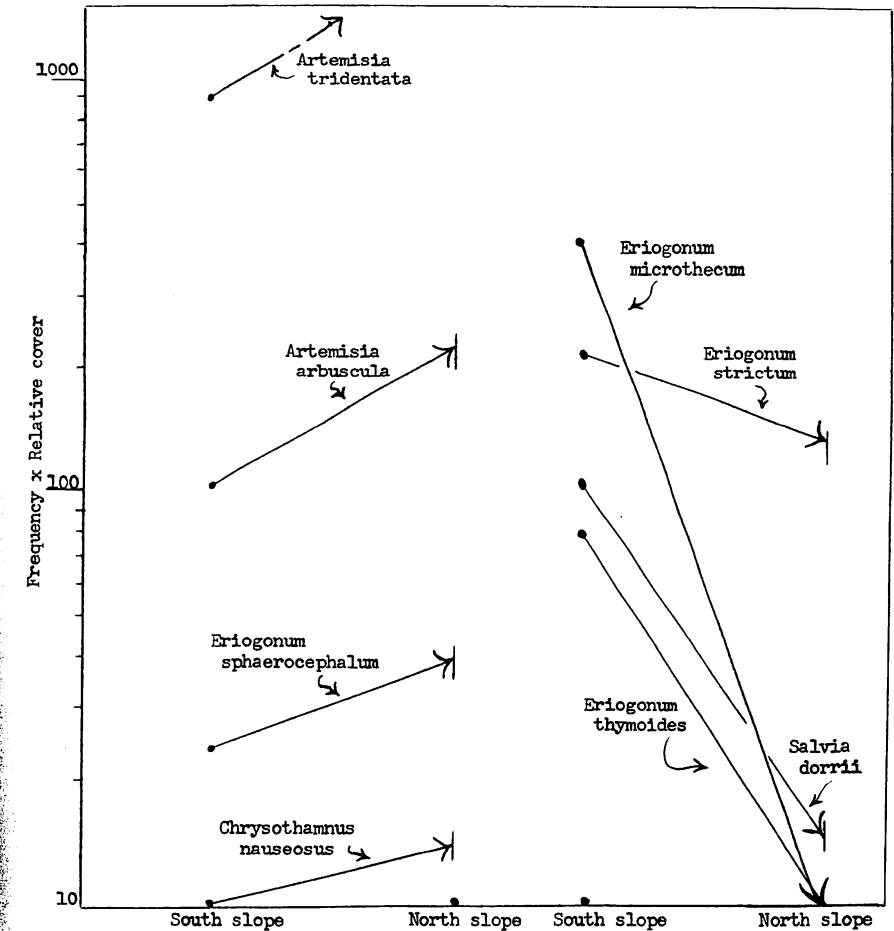


Figure 1. Behavior indices of the major shrub species as influenced by slope aspect in the lower elevations of Ginkgo State Park, Washington.

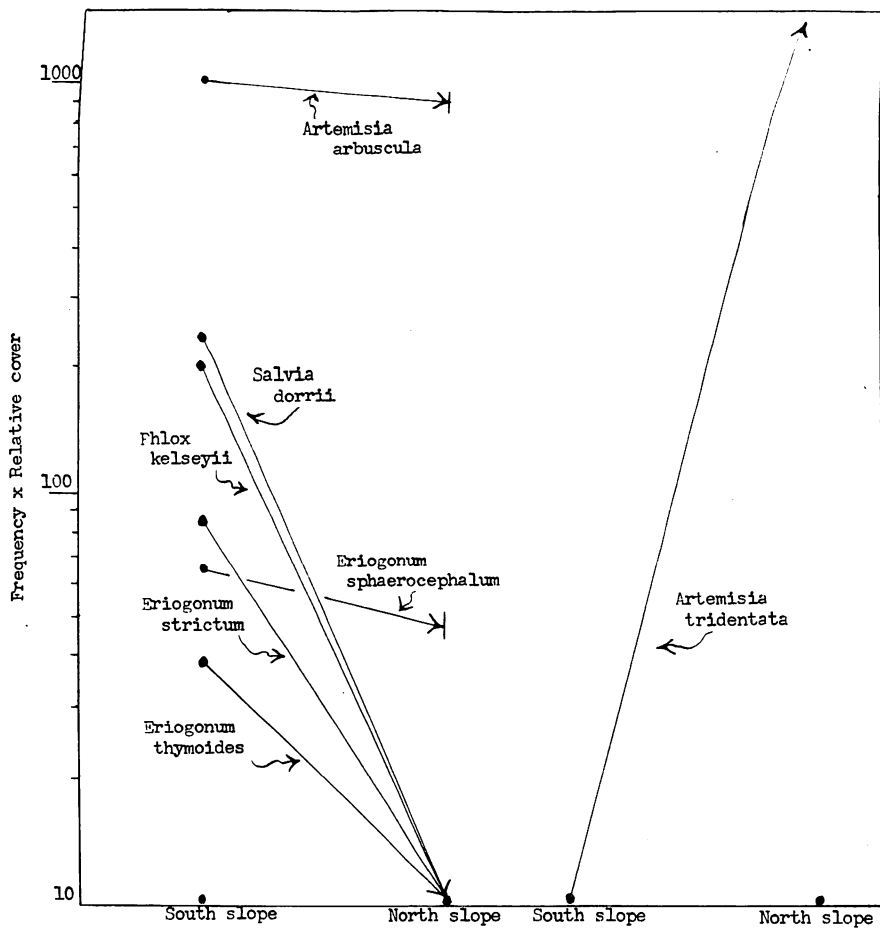


Figure 2. Behavior indices of the major shrubs species as influenced by slope aspect in the higher elevations of Ginkgo State Park, Washington.

Discussion

On the basis of the quantitative analysis, 11 woody species and one succulent represent the dominant flora of the existing shrub vegetation in Ginkgo State Park. When Importance Values of each of these species are compared on the basis of topography and elevation, species separation is identified (Table 1). The data show the shrub community is best characterized by two species of sagebrush, *Artemisia arbuscula* (dwarf or black sagebrush) and *A. tridentata* (big sagebrush). Topography and elevation are among the factors which influence the degree to which each associate. In the higher elevations, data show dwarf sagebrush to be more important in terms of cover and density. This position of importance is largely a matter of its greater density in the plains area and on south facing slopes (Table 1). Big sagebrush, however, tends

to increase in importance on north-facing slopes in the higher elevations (Table 1 and Figure 2), and particularly in areas where the soil is deeper and the texture less coarse. The data suggest that the shorter, more compact growth form of dwarf sagebrush might be more compatible with existing soil moisture and evaporative forces on south-facing slopes in the higher areas where the desiccating influence of wind during the early spring and summer months is more keenly felt.

In general, growth forms of the vegetation in the lower areas are larger when compared with vegetation in the higher elevations. Exposure to reduced wind velocity and moderate grazing in the lower areas might be used to help interpret vegetational and floristic differences in the two elevation regions. In lower elevations, south-facing slopes tend to be dominated by *Eriogonum microthecum*, *E. strictum*, *E. thymoides*, and *Salvia dorrii*, while north-facing slopes are characterized by *Artemisia arbuscula*, *A. tridentata*, *Chrysothamnus nauseosus*, *Eriogonum sphaerocephalum* and *Phlox kelseyii* (Fig. 1). In the higher areas of the park, south-facing slopes are dominated by *A. arbuscula*, *Eriogonum sphaerocephalum*, *E. thymoides*, and *Phlox kelseyii* (Fig. 2). It is noted that *Eriogonum microthecum* ceases to be of any importance in the higher elevations, and *E. strictum* shows a decline. On the other hand, *E. thymoides*, characterized by a more rosette growth form, increases in importance on higher elevation south-facing slopes.

The Importance Values and Behavior Indices presented (Table 1; Figs. 1 and 2) allow several of the 12 species which dominate the study area to be described as largely important through relative rates of increase or decrease, in either lower or higher elevations within the park. For example: *Artemisia tridentata*, *Eriogonum microthecum*, and *E. strictum* tend to be associated with the lower sites, while *Artemisia arbuscula*, *Eriogonum thymoides*, *Phlox hoodii*, *P. kelseyii*, and *Pediocactus simpsonii*, present increasing importance with increase in elevation.

When density is considered on an acre basis, data from Table 2 show an increase in plant density in the higher plains areas. This increase is principally due to an increase in *Artemisia arbuscula*, *Eriogonum thymoides* and *Phlox hoodii* (Table 1). These species do not contribute the cover that *Artemisia tridentata* provides in the lower elevations. As a result, the lower elevations of the park show a slight decrease in overall plant density, but present a much higher percentage of cover in the shrub vegetation, over half of which is contributed by *Artemisia tridentata*.

Microclimatic and edaphic differences are among factors which could be profitably investigated to help explain these trends. These areas are beyond the scope of this paper, but could form a basis of future work in the study area.

Summary and Conclusions

1. The shrub community occurring in Ginkgo State Park, Washington is characterized by patterns of distribution of 11 woody species and one succulent.
2. These species show patterns of distribution and density related to stand aspect and elevation. Their importance in each site is determined by relative values of frequency, density, and cover.
3. In general, two species of *Artemisia* (sagebrush) are the most important in all sites surveyed, with *A. arbuscula* (dwarf sagebrush) being more important on south-facing slopes and higher elevations. *A. tridentata* (big sagebrush) is more important on

north-facing slopes in both higher and lower elevations of the park (Table 1; Figs. 1 and 2).

4. In the lower elevations, south-facing slopes are characterized by *Eriogonum microthecum*, *E. strictum*, *E. thymoides*, and *Salvia dorrii*.

North-facing slopes in the lower elevations show the following species increasing in importance: *A. tridentata*, *Eriogonum sphaerocephalum*, and *Chrysothamnus nauseosus*.

5. In the higher elevations, south-facing slopes are characterized by *A. arbuscula*, *Eriogonum sphaerocephalum*, *E. thymoides*, and *Phlox kelseyii*. On these higher sites, *Eriogonum strictum* is important, but a decrease in importance is noted when compared to south-facing slopes in lower areas. *E. thymoides*, however, shows increased importance on south-facing slopes of the higher elevations when compared with those in the lower sites of the park.

North-facing slopes in the higher elevations are dominated by *Artemisia tridentata*, particularly where the soil is deeper and finer textured.

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The Frog Genus *Rana* in Montana

The frog genus *Rana* presents a large number of herpetological problems in the Pacific Northwest. Dumas (1964, 1966) discussed the *Rana* species complex in the Pacific Northwest with some references to Montana. The purpose of this paper is to clarify the distributional patterns of three *Rana* sp. in Montana. On the basis of two regions, based on vegetation and physiography, their distribution will be discussed. Distribution maps are based on numerous observations and over 500 collection records from 1965 to 1968.

The distribution of *Rana pretiosa* and *Rana pipiens* in Montana has been shown differently by Wright and Wright (1949), Stebbins (1966), and Dumas (1964, 1966). The occurrence of *Rana catesbeiana* in Montana was reported by Black and Bragg (1968). *Rana sylvatica* is often shown to occur in Montana, but these records require confirmation (Stebbins, 1966). Only *R. pretiosa*, *R. pipiens*, and *R. catesbeiana* will be discussed in this paper.

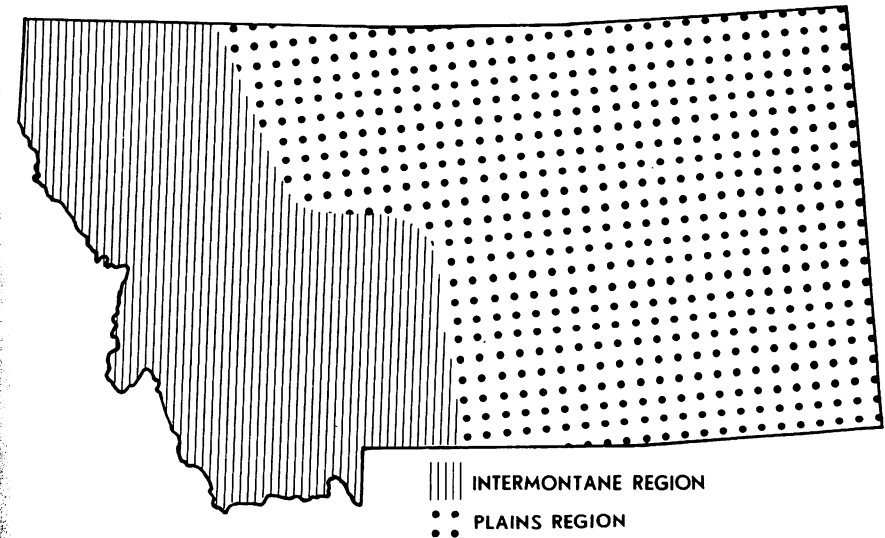


Figure 1. Regional classification of Montana based on vegetation and physiography.

Regional Classification

In the simplest classification, Montana can be divided into two regions based on vegetation and physiography. The intermontane region (Fig. 1), including much of the