Great Basin Naturalist

Volume 27 | Number 2 Article 1

9-5-1967

A comparative study of the mountain brush vegetation in Utah

Elray S. Nixon
Stephen F. Austin State College, Nacogdoches, Texas

The Great Basin Naturalist

Published at Provo, Utah by
Brigham Young University

Volume XXVII | September 5, 1967 | No. 2

A COMPARATIVE STUDY OF THE MOUNTAIN BRUSH VEGETATION IN UTAH[1]

Elray S. Nixon[2]

Abstract: A comparative study was made of an exclosure in the mountain brush vegetation of the Wasatch Mountains, Utah. The exclosure is located in Pole Canyon, near Provo, Utah, and was initially analyzed in 1948 and 1949 by Allman (1952, 1953). The dominant woody species of the vegetation in the exclosure were bigtoothed maple (*Acer grandidentatum*) and Gambel oak (*Quercus gambelii*). Results indicated that the maple had increased in relative cover whereas the oak decreased Serviceberry (*Amelanchier alnifolia*) had increased in both relative cover and frequency. Frequency data of forbs and grasses showed a general increase in early flowering annuals and perennials. Starflower (*Tellima parviflora*) and wyethia (*Wyethia amplexicaulis*) were two of the more prominent species which were new in the exclosure. The complete disappearance of western wheat grass (*Agropyron smithii*) from 67 percent frequency and the increase of Kentucky bluegrass (*Poa pratensis*) represented the greatest changes of grasses in the exclosure. Precipitation was recorded from May 1, 1958, to April 30, 1959. Soil data obtained included pH, soluble salt content, cation exchange capacities, mechanical analyses, and content of available calcium, magnesium, and potassium. Soils were analyzed at six-inch intervals to a depth of 24 inches.

Introduction

Allman (1952, 1953) presented a history of the study area and indicated that during the years that followed the first settlements in and around Provo, Utah, the area became heavily overgrazed by livestock. It was not until the late 1930's that the study site was included within the boundaries and management of the Uinta National Forest. As a result, grazing by livestock was restricted until 1949, when the study area was fenced and analyzed by Allman

1. Appreciation is extended to Dr. Earl M. Christensen (Brigham Young University, Provo, Utah) for suggestions and guidance, the late Dr. Merrill J. Hallam for aid in soil analyses, and to Mark Garrett for assistance with the field work.

2. Stephen F. Austin State College, Nacogdoches, Texas.

1952, 1953). The present study was proposed to determine any changes occurring within the exclosure since the initial study and to obtain certain environmental data which might supplement these results.

The exclosure is located in Pole Canyon, which is situated in the mountain brush vegetation to the northeast of Provo, Utah. It is specifically located in Section 9 of Township 6 South, Range 3 East, and is at an elevation of approximately 6,500 feet. The dominant woody species of the area are big-toothed maple (*Acer grandidentatum*) and Gambel oak (*Quercus gambelii*). Of less prominence are such species as serviceberry (*Amelanchier alnifolia*), ninebark (*Physocarpus malvaceus*), and snowberry (*Symphoricarpos vaccinioides*). The study was begun during the spring of 1958, and it continued through the summer of 1959.

Methods and Procedures

The exclosure consisted of 132 five-meter-square contiguous quadrats arranged on a grid. These quadrats were permanently marked and used to acquire frequency data for all species. Cover and relative cover data of the woody vegetation were obtained by the line-intercept method using a steel tape stretched along the grid lines separating the quadrats.

Three sites were chosen just outside the exclosure for collecting soil samples. At each site there were three collection points, one beneath an oak canopy, one beneath a maple canopy, and one beneath a herbaceous cover. Samples were taken at depths of 6, 12, 18, and 24 inches. Analyses of duplicate samples included pH, a mechanical analysis by the Bouyoucos hydrometer method, soluble salt content with the use of a salt bridge, cation exchange capacity by the ammonium acetate extraction method, and the amount of available calcium, magnesium, and potassium present by use of a Beckman flame-spectrophotometer. The moisture equivalents were determined by the centrifuge method. The wilting point of the soil was found by growing sunflower and wheat plants in glass tumblers in a greenhouse.

A rain gauge was placed inside the exclosure and precipitation measurements were taken from May 1, 1958, until April 39, 1959. These measurements were made the day after the storm unless the study area was inaccessible due to muddy roads. During the winter months of January, February, and March the area was entered on snowshoes; consequently, measurements were taken at the end of each month.

Results

Vegetation

Results concerning the woody vegetational cover of the exclosure indicated that the area could be divided into two vegetational types. The west part was located on a ridge and contained high proportions of both oak and maple (Table 1). The east part was located on a

Table 1. A comparison of the canopy cover of the east and west parts of the exclosure in 1949 and 1958

Species	West part (ridge)				East part (slope)			
	% Relative cover		% Cover		% Relative cover		% Cover	
	1949	1958	1949	1958	1949	1958	1949	1958
Maple	40.7	50.9	33.8	44.6	74.6	71.6	60.6	58.9
Oak	55.9	43.8	46.4	38.4	22.1	21.8	17.9	17.9
Serviceberry	1.0	2.9	0.8	2.5	2.0	3.4	1.6	2.8
Ninebark	0.0	0.4	0.0	0.4	0.0	0.9	0.0	0.7
Snowberry	0.0	0.5	0.0	0.4	0.0	0.4	0.0	0.3
Rose	0.0	0.2	0.0	0.2	0.0	Trace	0.0	Trace
Douglas fir	2.4	1.3	2.0	1.1	0.0	0.0	0.0	0.0
White fir	0.0	0.0	0.0	0.0	1.2	1.8	1.0	1.5
Juniper	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0
Total	100.0	100.0	83.0	87.6	100.0	99.9	81.2	82.1

east-facing slope and the canopy was predominantly maple. An analysis of the east part showed very little change during the nine-year period in regard to oak and maple cover (Table 1). The area upon the rise, however, revealed some significant changes. There was a definite increase of maple in the canopy and a decrease of oak. Along with this, the total vegetative cover increased by 4.6 percent. Young maple trees invaded and spread in the areas which were inhabited mainly by oak in 1949. The oak, on the other hand, did not invade the areas of older maple trees. There were few young oak plants under the older maple in the exclosure.

Although maple, oak, rose (*Rosa woodsii*), and snowberry increased somewhat in frequency, the only shrub showing any marked change was serviceberry which had increased 14 percent (Table 2). In addition, 50 seedlings of serviceberry were counted in 132 one-meter-square quadrats located at random in the five-meter-square quadrats. Although white fir (*Abies concolor*) showed no change in frequency, there were six seedlings noted within the exclosure.

In general, an increase in frequency occurred in the majority of forbs (Table 2). Spring beauty (*Claytonia lanceolata*), dog-tooth violet (*Erythronium grandiflorum*), blue-eyed Mary (*Collinsia parviflora*), waterleaf (*Hydrophyllum capitatum*), nemophila (*Nemophila breviflora*), and starflower (*Tellima parviflora*) increased throughout the exclosure. Plants which increased under the tall maples in the east part of the exclosure were Engelmann aster (*Aster engelmanni*), larkspur (*Delphinium nelsonii*), peavine (*Lathyrus spp.*), and violet (*Viola praemorsa*). Dandelion (*Taraxacum officinale*) and mullein (*Verbascum thapsus*) decreased in the east part. In the west part of the exclosure, which is more open, larkspur and wyethia (*Wyethia amplexicaulis*) increased, while arrowleaf balsamroot (*Balsamorhiza sagittata*) geranium (*Geranium fremontii*), goldenrod (*Solidago altissima*), and mullein decreased.

Species found in the exclosure in 1958 which were not recorded in the preliminary study were starflower, western valerian (*Valeriana occidentalis*), wyethia, western wallflower (*Erysimum asper-*

Table 2. Comparative frequency data of species

Species	% Frequency 1949	1958	Species	% Frequency 1949	1958
Abies concolor	11.4	11.4	*Nemophila breviflora*	62.1	84.8
Acer grandidentatum	98.5	100.0	*Osmorhiza divaricata*	84.8	93.2
Achillea lanulosa	34.8	31.1	*Osmorhiza occidentalis*	1.5	1.5
Agastache urticifolia	18.9	14.4	*Physocarpus malvaceus*	16.7	18.9
Agropyron smithii	67.4	0.0	*Poa curta*	15.2	12.1
Agropyron subsecundum	69.7	59.1	*Poa pratensis*	15.2	32.6
Amelanchier alnifolia	46.2	60.6	*Poa secunda*	1.5	9.1
Aster engelmanni	32.6	37.1	*Polemonium albiflorum*	1.5	0.0
Balsamorhiza sagittata	5.3	0.0	*Pseudotsuga taxifolia*	3.0	3.0
Bromus carinatus	59.1	45.5	*Quercus gambelii*	89.4	95.5
Calochortus nuttallii	0.8	0.0	*Rosa woodsii*	2.3	5.3
Carex spp.	90.9	91.7	*Rudbeckia occidentalis*	4.5	2.3
Cirsium undulatum	0.8	0.8	*Sambucus coerulea*	0.8	0.8
Claytonia lanceolata	0.8	80.3	*Scrophularia occidentalis*	6.1	8.3
Collinsia parviflora	32.6	71.9	*Smilacina spp.*	93.2	86.4
Delphinium nelsonii	3.0	14.4	*Solidago altissima*	6.8	0.0
Elymus glaucus	32.6	50.8	*Stellaria jamesiana*	89.4	95.5
Erigeron speciosus	25.8	18.2	*Stipa columbiana*	18.2	9.8
Erysimum asperum	0.0	0.8	*Stipa lettermani*	1.5	9.8
Erythronium grandiflorum	14.4	88.6	*Symphoricarpos vaccinioides*	6.1	9.9
Fragaria bracteata	11.4	14.4	*Taraxacum officinale*	34.9	25.8
Fritillaria atropurpurea	0.8	0.0	*Tellima parviflora*	0.0	39.4
Galium aparine	83.3	94.7	*Thalictrum fendleri*	0.8	1.5
Galium boreale	81.1	82.6	*Valeriana occidentalis*	0.0	2.3
Geranium fremontii	18.2	8.3	*Verbascum thapsus*	50.0	18.2
Helianthella uniflora	1.5	4.5	*Vicia trifida*	87.1	93.9
Hydrophyllum capitatum	22.7	90.2	*Viguiera multiflora*	31.1	28.8
Lathyrus spp.	78.8	99.3	*Viola adunca*	37.1	32.6
Mahonia repens	47.7	45.5	*Viola praemorsa*	14.4	23.5
Melica bulbosa	7.6	2.3	*Woodsia sp.*	0.8	0.8
Mertensia brevistyla	0.0	0.8	*Wyethia amplexicaulis*	0.0	5.3
Montia perfoliate	0.8	0.0			

um), and shortstyle bluebell (*Mertensia brevistyla*). Arrowleaf balsamroot, goldenrod, and white polemonium (*Polemonium albiflorum*) were forbs recorded in the initial study which were not found in the exclosure during 1958.

Of the grasses present, western wheatgrass (*Agropyron smithii*) underwent the greatest change. It decreased from 67.4 percent frequency to 0 percent. Other grasses which decreased were bearded wheatgrass (*Agropyron subsecundum*), columbia needlegrass (*Stipa columbiana*), and mountain brome (*Bromus carinatus*). Kentucky bluegrass (*Poa pratensis*), blue wild rye (*Elymus glaucus*), letterman needlegrass (*Stipa lettermani*), and Sandberg bluegrass (*Poa secunda*) increased.

Precipitation and Soil

Rain and snow measurements recorded within the study area showed a total of 16.18 inches of precipitation during the year with about four-fifths of it being recorded from November to May (Fig. 1). Only 3.09 inches of rain fell from May 14 to November 7 and this

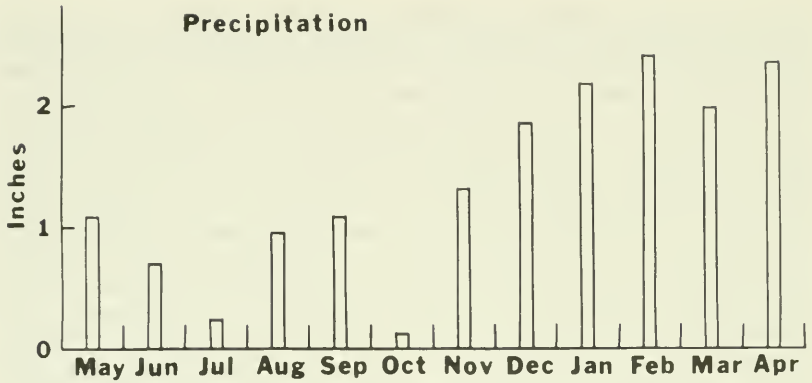

Fig. 1. Precipitation data obtained from within the exclosure.

was a result of 11 different storms. The highest amount of precipitation, 2.4 inches, was recorded in February. The snow depth at that time averaged about 30 inches. The smallest amount of precipitation fell in October when .12 of an inch was recorded. July was also very dry with only .23 of an inch of rainfall. Only one storm occurred in each of these months.

The parent material of the soil of the study site was composed of subordinate limestones and quartzites (Allman 1952). The A horizon was fairly well developed but varied in depth extending in places to more than 24 inches. On the ridge area in the exclosure it was as shallow as 6 inches. The B horizon was not as variable and in some places was poorly developed. The C horizon was as close to the surface as 15 inches but in most cases was at a depth of 24 inches or more. Rocks occurred throughout the profile.

The texture of the soil was a loam or silt loam and in every case bordered the dividing line between these two classes (Table 3). Soil

Table 3. Average soil data under oak, maple, and herbaceous vegetative types.

	Depth in inches			
	0-6	6-12	12-18	18-24
Mechanical analysis				
% Sand	34.7	36.5	37.9	38.2
% Silt	53.3	49.2	46.4	44.7
% Clay	11.9	14.3	15.7	17.1
Soil type	Silt Loam	Loam	Loam	Loam
pH	6.6	6.5	6.5	6.7
Soluble salts (ppm)	150.7	124.8	148.9	171.1
Cation exchange (me/100 gms)	40.3	31.4	27.4	24.2
Ca (ppm)	768.0	631.0	574.0	547.0
Mg (ppm)	617.0	416.0	380.0	404.0
K (ppm)	379.0	172.0	103.0	71.0
Moisture equiv. (%)	31.0	25.0	24.5	22.4
Wilting point (%)	10.4	9.4	9.2	9.4

pH ranged from 5.9 to 7.4 with an average of 6.6. Generally there was little variation to a depth of 24 inches, and there was no significant difference in pH of soils under maple, oak, or herbaceous cover. Soluble salt content of the soils was comparatively low since, in most instances, they contained less than 200 ppm. The concentration was found to increase with depth with the exception of the first 6 inches which usually contained higher amounts than the 12- and 18-inch levels. Cation exchange capacities of the soils ranged from 22.5 to 42.9 meq. per 100 g of soil. They always decreased with depth being highest in the top 6 inches. The cation exchange capacity was lower in the surface soil of the herbaceous sites than it was under oak and maple where more organic matter was present. An increase in soil depth was usually accompanied by a decrease in available calcium, magnesium, and potassium. Each of these elements appeared to be relatively abundant with the possible exception of potassium at the 24-inch level (Table 3). The moisture equivalents and wilting points of the soils showed little variation under the different canopy types.

Discussion

The mountain brush-type vegetation in the canyons and on the mountain sides in the vicinity of the study area is, in most places, dominated by Gambel oak (*Quercus gambelii*). Allman's observations of the exclosure made in 1948-49 led him to conclude that maple (*Acer grandidentatum*) would eventually replace oak and serviceberry (*Amelanchier alnifolia*) in the lower ravines. Christensen (1958) studied succession in reference to growth rates of maple and oak in Pole Canyon and also concluded that maple was becoming more significant in the composition of the vegetation. The results of this study support these conclusions. On the ridge area where oak was more prominent, young maples were spreading throughout the oak. Maple freely invaded the oak brush, but it appeared that oak had difficulty invading the maple.

The reasons maple increased at the expense of the oak are still hypothetical. Christensen (1950) and Allman (1952) suggested that competition with shade-tolerant species could cause the oak to decrease. Some support for this suggestion exists since there is a greater abundance of forbs under the maple canopy than under the oak. Allman (1953) found as many as 31 different species in one five-meter-square quadrat under the maple. In this study there was an average of 19 species per quadrat in the east half which was predominantly maple and an average of 15 species per quadrat in the west half where more oaks were present. There was not only a greater variety of species present under the maple, but also the density of these species was greater. Since oak brush in the exclosure and in other areas (Moinat, 1956; Brown, 1958) has fewer herbs beneath its canopy, maple stolons and seedlings could invade this area more freely.

Both maple and oak reproduce vegetatively and by seeds. The maple, however, produces many more seeds than the oak; and ap-

parently these seeds are not as subjected to biotic influences as are the oak acorns (Christensen, 1955). Seedling data has indicated that maple is quite efficient in reproducing by seed, especially in new areas, giving it a decided advantage over oak brush in reproductive potential (Christensen and Nixon, 1964).

Among other woody species in the exclosure, serviceberry was the only one which changed markedly. The fact that serviceberry increased 14 per cent in frequency and that there were many seedlings and young plants present is evidence that it may continue to increase in the future. Cottam and Evans (1945) reported a density of .39 for serviceberry in an ungrazed canyon and a density of .19 in a grazed canyon (the term density, as used by Cottam and Evans, represents percentage of plant cover obtained by the point-observation-plot method).

The exclusion of grazing has brought about various changes in the forbs and grasses of the exclosure. Undesirable species such as mullein (*Verbascum thapsus*) and dandelion (*Taraxacum officinale*) decreased considerably in frequency. The increase of annuals and small perennials denoted one of the interesting changes. The annuals, nemophila (*Nemophila breviflora*), bedstraw (*Galium aparine*), and the winter annual blue-eyed Mary (*Collinsia parviflora*), increased considerably in frequency. Small perennials such as spring beauty (*Claytonia lanceolata*), dog-tooth violet (*Erythronium grandiflorum*), and waterleaf (*Hydrophyllum capitatum*) also increased markedly. McKell (1950) found that annual plants increased greatly the first season after a fire in the mountain brush vegetation but that perennials were slower in their recovery. The increase of larger perennials such as Engelmann aster (*Aster Engelmanni*), sweet anise (*Osmorhiza divaricata*), and figwort (*Scrophularia occidentalis*) has been slow. The large perennial forbs are generally found among the more open-type vegetation such as the tall maples. Therefore, their increase will probably accompany the increase in maple.

Kentucky bluegrass (*Poa pratensis*) spread under the tall maple and into the open areas. In Colorado, Moinat (1956) reported that Kentucky bluegrass was the dominant plant under the oak. Cottam and Evans (1945) found that the density of the palatable grasses, mountain brome (*Bromus carinatus*), Kentucky bluegrass, and Sandberg bluegrass (*Poa secunda*), was five times greater in an ungrazed canyon than in a grazed canyon. Sandberg bluegrass increased in this study, but mountain brome decreased in frequency. Ellison and Houston (1958) found that production of *Bromus carinatus* in aspen openings was greater than under aspen canopy. Their results also showed an increase of production with increase in altitude. The altitudinal location of the exclosure is probably near the lower limits of the distribution of this grass. The decrease of western wheatgrass (*Agropyron smithii*) was one of the greatest changes. Its high frequency at the time of the preliminary study is evidence that it can compete under grazing conditions. Moinat (1956) and Brown (1958) noted that western wheatgrass was the dominant grass in the

openings between the oak, but it produced very little under the oak.

The exclosure received a total precipitation of 16.18 inches, most of which arrived during the winter months. The summer storms were of light intensity and occurred at fairly long intervals. This resulted in one of the driest summers in Utah history. Only 3.09 inches of rainfall fell from May 14 to November 7. Price and Evans (1937) recorded 7.01 inches in Ephraim Canyon, and Allman (1952) registered 7.79 inches of rain from May 14 to August 25. Allman also found that precipitation measured in the exclosure during a ten-month period amounted to 22.57 inches. This was one of the wettest years in Utah history. Baker and Korstian (1931), Price and Evans (1937), Lull and Ellison (1950), Moinat (1956), and Brown (1958) recorder measurements between 15 and 20 inches of precipitation for oak brush areas.

Soil results indicated that conditions were generally favorable for plant growth. The findings were usually similar to those of Allman (1953) and, in some instances, comparable to Baker and Korstian's (1931) and to Price's (1938) results from mountain brush areas. Although soil characteristics varied, there were no significant differences under the various canopy types.

List of References

Allman, V. P. 1952. A preliminary study of the vegetation in an exclosure in the chaparral of the Wasatch Mountains, Utah. M.S. thesis, Brigham Young University.

———. 1953. A preliminary study of the vegetation in an exclosure in the chaparral of the Wasatch Mountains, Utah. Proc. Utah Acad. Sci., Arts, and Letters, 30:63-73.

Baker, F. S. and C. F. Korstian. 1931. Suitability of brushlands in the intermountain region for the growth of natural or planted western yellow pine forest. U. S. Dept. Agr. Tech. Bull., 256:1-82.

Brown, H. E. 1958. Gamble oak in west central Colorado. Ecology, 39:317-327.

Christensen, E. M. 1950. Distributional observations of oak brush (*Quercus gambelii*) in Utah. Proc. Utah Acad. Sci., Arts, and Letters, 27:22-25.

———. 1955. Ecological notes on the mountain brush in Utah. Proc. Utah Acad. Sci., Arts., and Letters, 32:107-111.

———. 1958. Growth rates and vegetation change in the oak-maple brush in lower Provo Canyon, Utah. Proc. Utah Acad. Sci., Arts, and Letters, 35: 167-168.

Christensen, E. M. and E. S. Nixon. 1964. Observations on reproduction of bigtooth maple. Leafl. Western Bot., 10:97-99.

Cottam, W. P. and F. R. Evans. 1945. A comparative study of the vegetation of grazed and ungrazed canyons of the Wasatch Range, Utah. Ecology, 26:171-181.

Ellison, L. and W. R. Houston. 1958. Production of herbaceous vegetation in openings and under canopies of western aspen. Ecology, 39:337-345.

Lull, H. W. and L. Ellison. 1950. Precipitation in relation to altitude in central Utah. Ecology, 31:479-484.

McKell, C. M. 1950. A study of succession in the oak brush (*Quercus gambelii*) zone after fire. M.S. thesis, University of Utah.

Moinat, A. D. 1956. Comparative yields of herbage from oak scrub and interspersed grassland in Colorado. Ecology, 37:852-854.

Price, R. 1938. Artificial reseeding on oak brush range in central Utah. U. S. Dept. Agr. Circ., 458:1-18.

Price, R. and R. B. Evans. 1937. Climate of the west front of the Wasatch Plateau in central Utah. U. S. Monthly Weather Rev., 65:291-301.