Vegetation And Soils Of Alkali Sagebrush And Adjacent Big Sagebrush Ranges In North Park, Colorado

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Highlight

Alkali sagebrush ranges were found to have a shallow, root restricting claypan soil. In contrast, the adjacent big sagebrush plant community occurred on loamy soils where roots penetrated freely. This direct relationship between range sites and soils shows how soil surveys can be used to determine range sites.

In North Park, Colorado an unusual sagebrush plant community stands out in sharp contrast with other kinds of sagebrush rangelands. While the boundaries of other plant communities change gradually, the boundary of this plant community is sharp and distinct. A low growing sagebrush species sets aside this plant community from all others. The species is alkali sagebrush *(Artemisia longiloba* (Osterhout) Beetle) as identified by Beetle (1960). The local name for this species is "chicken sage."

Many have questioned why solid stands of this plant occur in blocks of a few acres to several hundred acres to the exclusion of other sagebrush species—then abruptly change on a sharp line to big sagebrush *(Artemisia tridentata* Nutt.).

This paper describes the vegetation and soils occurring on this range site, and compares both to the vegetation and soils on adjacent range sites having a cover of big sagebrush.

Beetle described alkali sagebrush as a dwarf, dark gray-green shrub which "stands strikingly alone in two respects; first its extremely early maturity which normally prevents crossing with any other species in the section, and secondly, its adaptation to tight-to-heavy soils derived from highly alkaline shales." He showed its distribution on "poorly drained or tight and highly alkaline soils from 6,000 to 8,000 feet elevation, in the vicinity of the foothills of the ranges forming the Continental Divide from southwestern Montana, through Wyoming to northwestern Colorado, and at scattered localities westward in northern Utah and Nevada and southern Idaho and Oregon." Passey and Hughie (1962) differed with the placing of alkali sagebrush on "poorly drained or tight and highly alkaline soils." Soils on which this species dominated, they found, were slightly alkaline to slightly acid in reaction.

Thatcher (1959) and others have shown that big sagebrush evidently requires at least moderately deep soils in order to dominate a plant community and avoids shallow soils. Thatcher found that the depth of soil to which big sagebrush (where dominant) could freely penetrate was at least 15 inches on 17 sites studied, and there were only two sites where the effective soil depth was less than 36 inches.

Study Area and Methods

North Park and North Park Soil Conservation District cover a high mountain valley which drains the headwaters of the North Platte River. It is a park about 40 miles long and 30 miles wide surrounded by mountains. The precipitation at Walden near the center of the park is 9.47 inches, the frost-free period is 46 days, and the mean annual temperature is 37.1 F. The elevation at Walden is 8,132 feet. The precipitation increases markedly toward the mountains so that the average annual precipitation nine miles east, where much of this data was gathered, is estimated to be 15 inches at an elevation of 8,400 feet. Low rounded hills of the Coalmont and Pierre shale formation are the loca-

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tion of this site in the North Park soil survey area. Sandstone beds near the top of these formations form minor hogbacks. This feature creates a banding effect as seen from the air (Rocky Mountain Association of Geologists-1957). Soils derived from Coalmont and Pierre shales support a plant cover dominated by alkali sagebrush. Soils derived from the sandstone hogbacks support a higher producing plant cover dominated by big sagebrush. These bands are often no more than 150 feet wide with abrupt vegetation and soil boundaries (Fig. 1). The alkali sagebrush-dominated range site is called "Claypan," and the adjacent big sagebrush site is called "Mountain Loam."

Eight study areas were selected in the Claypan range site, and for comparison, 5 study areas were selected in the adjacent Mountain Loam range site. Soil pits were dug and profiles described for each of the 13 areas. Soil samples were taken and laboratory analyses were obtained from 7 of the study areas. Profiles of the other 6 soils were described and analyzed by field methods. Plant composition and production were determined for each location (Fig. 2).

Range study plots, 9.6 ft^2 in size, were located in the vicinity of the soil pits. Current year's growth of each species was clipped to ground level, placed in separate sacks, air dried, and weighed in grams. Current year's growth of shrubs was removed and weighed in grams. The productivity of each plot was expressed in lb/acre of air dry herbage.

Soil profiles were described and sampled in the manner outlined in the Soil Survey Manual (1951). Laboratory determinations included pH, both paste and 1-5 dilution, total soluble salt content, gravimetric salts, organic matter, lime, particle size distribution, saturation moisture, cation exchange capacity, exchangeable sodium percentage, and exchangeable potassium percentage. In addition to the laboratory analyses and usual field tests, kind and amount of root material were determined visually for each horizon. Density and size of cracks between aggregates were also observed.

Results

A summary of composition by weight of major species, total yield, and crown cover density for the Claypan and Mountain Loam range sites is shown in Table 1. A summary of important soil characteristics of the two range sites is shown in Table 2.

Each profile of the Claypan soils had two definite soil zones. The upper zone consisted of granular, friable soil that allowed easy circulation of air, water, and root growth of all kinds. The second zone consisted

Fig. 1. Mountain Loam range site, foreground, and Claypan range site, center rear.

Fig. 2. Soil Conservation Service technicians making vegetative and soils studies of the Claypan range site in conjunction with the North Park Standard Soil Survey, Jackson County, Colorado.

Table 1. Summary of percent composition by weight for major species, total annual yield in lb/acre airdry, and crown cover density in percent for the Claypan and Mountain Loam range sites.

Species	Composition Claypan	Composition Mountain Loam
Alkali sagebrush *(Artemisia longiloba* (Osterhout) Beetle)	36	—
Big sagebrush *(Artemisia tridentata* Nutt.)	—	54
Bearded bluebunch wheatgrass *(Agropyron spicatum)*	10	—
Streambank wheatgrass *(Agropyron riparium)*	5	—
Thickspike wheatgrass *(Agropyron dasystachyum)*	—	2
Idaho fescue *(Festuca idahoensis)*	—	26
Pine needlegrass *(Stipa pinetorum)*	8	3
Prairie junegrass *(Koeleria cristata)*	6	—
Muttongrass *(Poa fendleriana)*	3	—
Nevada bluegrass *(Poa nevadensis)*	—	2
Sandberg bluegrass *(Poa secunda)*	4	—
Bottlebrush squirreltail *(Sitanion hystrix)*	—	2
Hoods phlox *(Phlox hoodii)*	11	—
Vasey rabbitbrush *(Chrysothamnus vaseyi)*	11	—
Total annual yield—all species	510	974
Crown cover density	20	35

Table 2. Summary of important soil characteristics of the Claypan and Mountain Loam range sites.

Claypan Soils	Thickness	Texture	Structure	Organic Matter %	pH	Exch. Sodium Percent
Non-restrictive Zone	Less than 10 inches except one of 16 inches	Sandy loam to clay	Granular	1.5 to 2.6	6.2 to 7.1	Negligible
Restrictive Zone	8 to 29 inches	Sandy clay loam to clay	Angular blocky	0.6 to 1.5	6.7 to 8.1	1.9 to 8.0
Mountain Loam Soils						
Topsoil	5 to 7 inches	Sandy loam to loam	Granular	4.0 to 5.3	6.0 to 6.1	Negligible
Subsoil	30 to 36 inches	Sandy clay loam to clay loam	Sub-angular blocky	Less than 1.0	6.2 to 6.5	Negligible

of dense, tight layers with moderate angular blocky structure which severely restricted the circulation of air and water and the penetration of all but the finest roots. The two zones are identified in this discussion as (1) nonrestrictive and (2) restrictive. No similar zone separations were observed in the Mountain Loam soils.

In the Claypan soils, the grade of structure development in the restrictive zone was moderate to strong. An angular blocky structure was always present. The larger roots of shrub species were observed to make right-angle turns upon contacting the restrictive zone. This suggests the existence of a rapid-swelling, slow-shrinking clay fraction in the restrictive zone. These observations would indicate that the clay fraction of the restrictive zone has two principal properties which limit the penetration of roots: (1) The aggregates swell rapidly upon wetting and all voids are closed before roots can extend through the restrictive layers. (2) When the soil dries and very small shrinkage cracks occur, there is insufficient available moisture for root growth. Larger roots penetrating any structure voids may be sheared off by the sharp edges of the aggregates during the swelling process. A rather low-producing plant community of alkali sagebrush and other shallow rooted, drouth-adapted shrubs, grasses, and forbs are able to survive under these soil conditions (Fig. 3).

The Mountain Loam soils had upper horizons that consisted of granular, friable soil that allowed easy circulation of air, water, and root growth of all kinds.

The subsoil consisted of moderate subangular blocky structure that allowed normal penetration of both large and small roots, and free circulation of air and water.

Big sagebrush and associated deep-rooted plants grow on the loamy soils, whereas shallow rooted drouth-adapted alkali sagebrush and associated plants occupy the Claypan soils. (Table 1).

This study points out the direct relationship between range sites and kinds of soil. By determining kinds of soil that are included in a range site and establishing soil mapping legends for the rangeland, the boundaries of soil mapping units can be used to determine the boundaries of range sites. The range sites and soils in the North Park soil survey area have been correlated in this manner, and this is being done throughout the United States as part of the National Cooperative Soil Survey.

Fig. 3. Cattle grazing the Claypan range site, Jackson County, Colorado.

Summary

In North Park, Colorado, the alkali sagebrush plant community stands out in sharp contrast from adjacent sagebrush range. Its abrupt boundary makes it an excellent site on which to study range site and soil correlation.

In preparing the legend for the North Park Standard Soil Survey, the soil and vegetation of this site were compared with the adjacent big sagebrush dominated range site.

A marked difference occurs in plant composition, total annual plant yield, and soil characteristics between the Claypan (alkali sagebrush) and the Mountain Loam (big sagebrush) range sites. These differences were consistent throughout the area studied.

The Claypan range site is the result of a shallow, restrictive soil zone which prohibits the penetration of all but the finest roots. The alkali sagebrush plant community, being drouth-adapted, can survive under this condition. On the other hand, this soil characteristic precludes the survival of big sagebrush and associated species. The big sagebrush community occurs only on moderately deep to deep, loamy soils where deep root penetration is possible.

After range sites and soils are correlated, it is possible to determine range sites from the soil survey. This is being done throughout the United States today by the National Cooperative Soil Survey.

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