Some Plant-Soil Relationships on an Ungrazed Range Area of Southeastern Idaho

H. B. PASSEY AND V. K. HUGIE

Range Conservationist and Soil Scientist, Soil Conservation Service, Salt Lake City, Utah

A problem encountered in range site delineation is that of confusing sites with range condition classes. This problem arises most frequently when too much reliance is placed on the present vegetation and too little on soil and climatic factors in the identification of sites on ranges subjected to heavy grazing or other disturbance.

The effect of disturbance on plant communities was aptly described by Dyksterhuis (1958) as follows: "The physical environment, with all of its climatic and edaphic factors and their innumerable interactions and gradients, supports many measurably different plant communities in apparent stability with local site conditions. When grazing by domestic livestock is superimposed by thousands of owners with tens of thousands of pastures grazed in various ways, the climax pattern tends to be obscured, and there is an overall increase in the number of plant communities."

Because of such disturbance, the vegetation of a high producing site in fair or poor range condition may closely resemble that of a low producing site in excellent or even pristine condition. Under such circumstances, two dissimilar areas may be mistakenly referred to as the same range site. Likewise, two similar areas may be interpreted as two different range sites because of difference in present vegetation. A potential source of error in range site delineation lies in the need for differentiating between plant communities which express the inherent site potential and similar communities resulting from disturbance.

Soil and climatic factors known to be associated with specific natural plant communities, because of their permanence, thus become more reliable indicators of range sites than does the nature of an altered plant community.

The methods used on areas of relict vegetation in determining the relationship between potential plant communities and their associated environmental factors are described elsewhere (Passey and Hugie 1962).

The natural plant communities of two distinctly different but adjacent soils within a relict range area of southeastern Idaho contain the same plant species but differ significantly in species composition and in herbage production. The purpose of this paper is to compare these two plant communities and to describe their relationship to the soils on which they occur. The studies reported are a part of the soil-vegetation-climatic relationship investigations conducted by the Soil Conservation Service from 1958 through 1961 in the area of study.

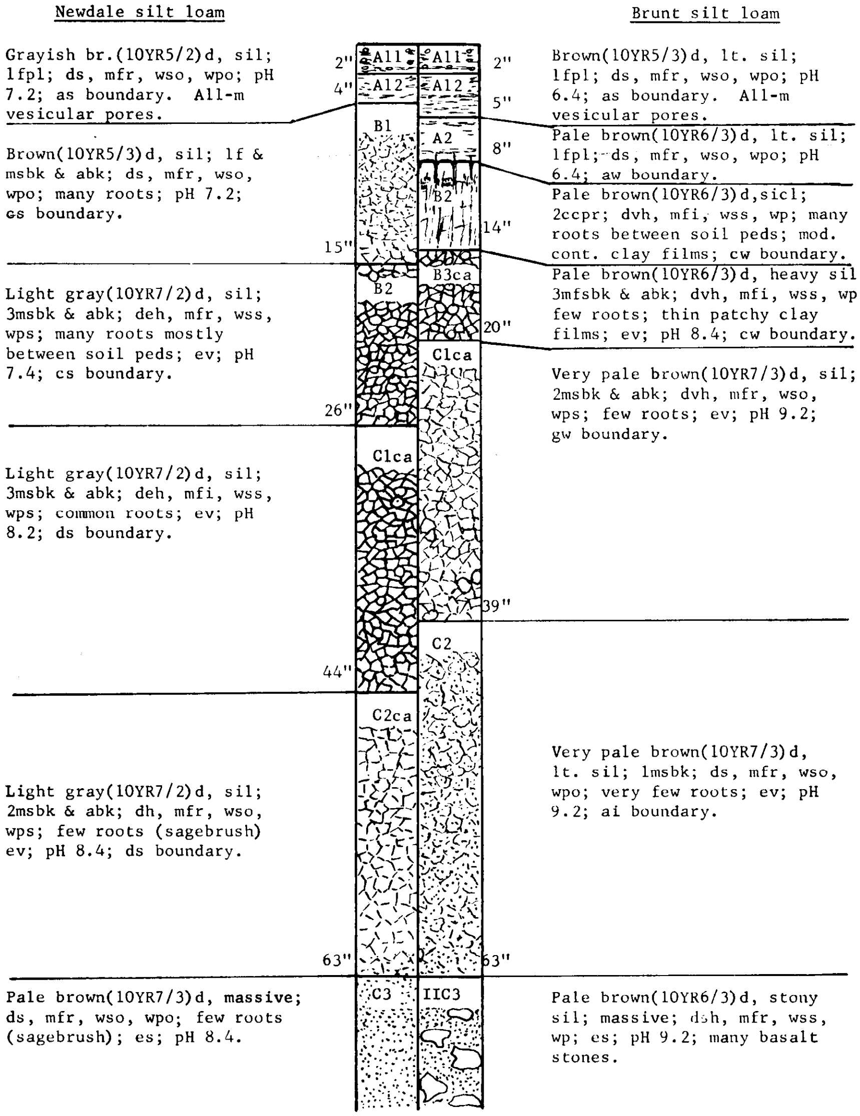
The Study Area

Studies were conducted within a relict "kipuka" area of approximately 80 acres located 20 miles north of Blackfoot, Idaho. A "kipuka" is defined as a natural land area which has become isolated by a flow of lava of more recent origin than the land surface itself and which completely surrounds it.

The kipuka is at an elevation of 4920 feet. Average annual precipitation is estimated to be about 10 inches and mean annual temperature about 44° F. Precipitation is fairly evenly distributed throughout the year except that June, July and August are comparatively dry. The surface of the kipuka is gently undulating and there are no defined drainage patterns. Slopes range from less than one percent to a maximum of about four percent.

While it would be possible for livestock to cross the mile or more of rough, fissured pahoehoe lava, surrounding the kipuka, the risk of loss enroute and the lack of water on the kipuka makes it likely that the area has never been heavily grazed by livestock. There is currently no evidence of trailing, trampling or other indications of livestock use, nor is there any indication of burning. Deer and antelope occasionally cross the kipuka and there is evidence of a small rodent population. From all available evidence, the vegetation appears to be undisturbed and can be considered as representative of the potential native plant communities for the sites involved.

The vegetation of the kipuka is dominated by an open savanna-like stand of big sagebrush (*Artemisia tridentata* Nutt.) with an understory of grasses including bluebunch wheatgrass (*Agropyron spicatum* (Pursh) Scribn. and Smith), Thurber needlegrass (*Stipa thurberiana* Piper), Sandberg bluegrass (*Poa secunda* Presl.), and bottlebrush squirreltail (*Sitanion hystrix* (Nutt.) J. G. Smith); a few small forbs including tapertip hawksbeard (*Crepis acuminata* Nutt.), western hawksbeard (*C. occidentalis* Nutt.), longleaf phlox (*Phlox longifolia* Nutt.), Hood's phlox (P. hoodii Richn.), and Macdougal lomatium (*Lomatium macdougali* C. & R.); small amounts of such shrubs as Douglas rabbitbrush (*Chrysothamnus viscidiflorus* (Hook) Nutt.), threetip sagebrush (*A. tripartita* Rydb.), and plains pricklypear (*Opuntia polyacantha* Haw.); and a very small population of



Note: Abbreviations used in this Figure defined in Soil Survey Manual, USDA Handbook No. 18, pages 139-140. Scale 1/8" = 1". pH determined in the field with indicators.

FIGURE 1. Characteristics of soils cited.

annual species, mostly yellow owlclover *(Orthocarpus luteus* Nutt.) and cheatgrass brome *(Bromus tectorum* L.), Utah juniper *(Juniperus osteosperma* (Torr.) Little), Rocky Mountain juniper *(J. scopulorum* Sarg.) and antelope bitterbrush *(Purshia tridentata* (Pursh.) D. C.) grow on the surrounding lava but do not occur within the kipuka except on small basalt outcroppings.

Soils of the kipuka are formed in aeolian parent materials which were derived principally from metamorphic and igneous rock. The thickness of the loess mantle over the underlying basalt is variable and ranges from a few inches to several feet. Newdale silt loam (tentative) and Brunt silt loam (tentative) are the dominant soil types in the kipuka and were studied separately. The Newdale silt loam is a deep, medium textured, well-drained, moderately permeable Brown soil. This soil has a weak (structural) B horizon and is leached of carbonates to a depth of 26 inches. Field pH determinations of the Newdale silt loam indicate that sodium salts are not concentrated or a problem in plant growth. Approximately 60 percent of the soil surface is barren in this soil.

The Brunt silt loam is a deep, moderately well-drained, slowly permeable Solodized Solonetz soil. This soil is leached of carbonates to a depth of 14 inches and is characterized by a textural, columnar (solonetzic) B horizon. The solonetzic B horizon development varies somewhat. It is moderate to strong under barren areas and weak to moderate under vegetation. Sodium salts are concentrated in the lower horizons and a factor in plant growth. About 80 percent of the soil surface is barren in the Brunt soils. Frost heaving of shallow-rooted plants and surface crusting (dispersion) were more noticeable on the Brunt silt loam than on Newdale silt loam. Characteristics and a more detailed comparison of these two soils are presented in Figure 1.

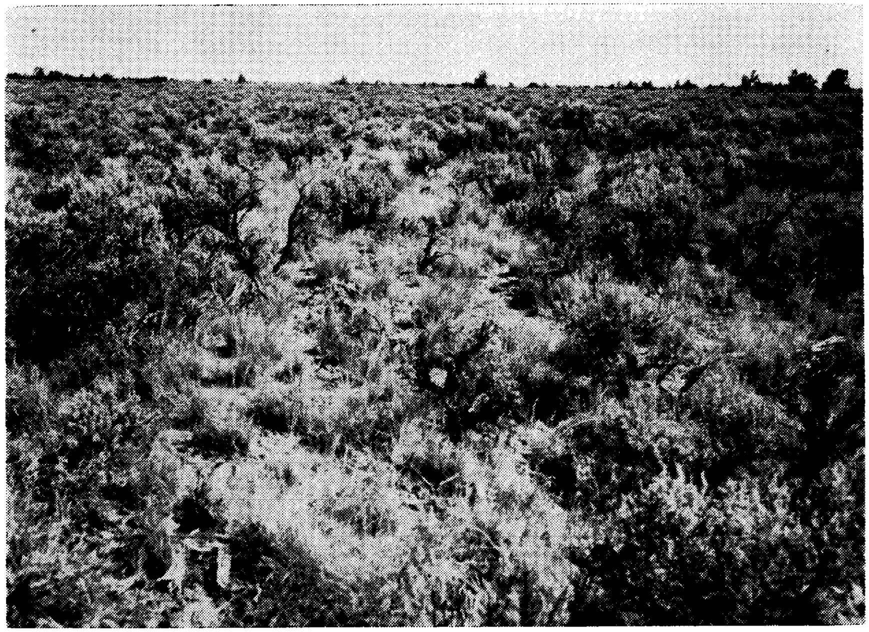


FIGURE 2. Study Location No. Ida. 4-59 showing typical vegetation of the Newdale silt loam soil.

Methods

Study locations approximately 200 x 200 feet in size, on which soil and vegetation were judged to be homogeneous and uniform, were delineated on areas represented by the two soils studied (Figures 2 and 3).

Vegetation was sampled during June 1959 on each location by clipping and weighing the current year's growth of each plant species on three closely spaced plots of 9.6 square foot area and by estimating the

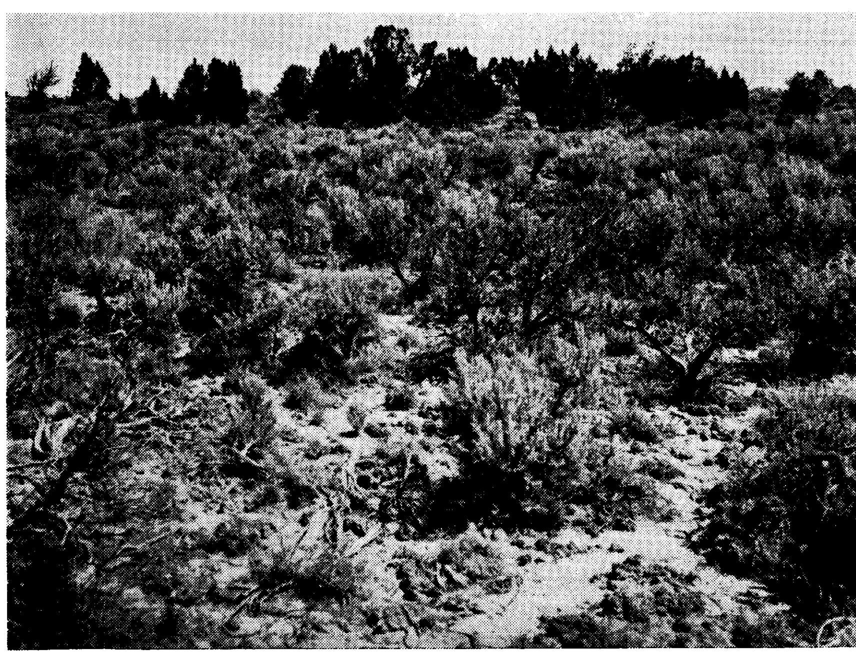


FIGURE 3. Study Location No. Ida, 6-59 showing typical vegetation of the solonetzic Brunt silt loam soil.

Table 1. Average air-dry herbage production and species composition on two soils of an ungrazed range area for the period 1959-1961.

Species	Brunt silt loam Pounds/ Ac.	Brunt silt loam Percent Comp.	Newdale silt loam Pounds/ Ac.	Newdale silt loam Percent Comp.
Bluebunch wheatgrass	41	12	262	38
Thurber needlegrass	5	1	89	13
Sandberg bluegrass	50	15	53	8
Bottlebrush squirreltail	59	18	3	1
Western and tapertip hawksbeard	27	8	35	5
Longleaf and Hood's phlox	12	4	19	3
Macdougal lomatium	17	5	28	4
Other forbs	16	5	35	5
Big sagebrush	96	28	136	20
Threetip sagebrush	2	1	14	2
Douglas rabbitbrush	5	1	6	1
Plains pricklypear	6	2	—	—
All annuals	1	T*	2	T*
Totals	337	100	682	100

*T—indicates less than 1 percent of the composition.

weight of each species on an additional 20 plots of the same size located at random within each study location. Total air-dry herbage weight and the weight of each species was converted to a pounds per acre basis by the method described by Frischknecht and Plummer (1949). Species composition was expressed in terms of the percent of total herbage contributed by each species. Herbage yield and species composition during 1960 and 1961 were determined in the manner described above except the three closely spaced plots were eliminated and three of the 20 random plots were clipped. Average herbage production and average species composition for the three-year period of study on each study location are shown in Table 1.

Detailed notes were recorded on the size, number of inflorescences and growth form of the major plant species, the age of oldest shrubs, and the amount and distribution of mulch.

A soil pit was dug to a depth of 72 inches within the area covered by the three closely spaced plots of the 1959 studies on each location. Soil profiles were examined and described in the manner outlined in the Soil Survey Manual (Soil Survey Staff, 1951). The nature and extent of roots within the soil, presence of soil fauna and the nature of soil surfaces were recorded. Estimates were made of the percent of the soil surface covered by vegetation and mulch and the percent which was bare.

Results

Herbage Production and Composition

The herbage production and plant species composition on the two soils studied are presented in Table 1.

The average air-dry herbage yield for the three-year period of study was 682 pounds per acre on the Newdale silt loam soil of Study Location No. Ida. 4-59, and 337 pounds per acre on the solonetzic Brunt silt loam soil of Study Location No. Ida. 6-59.

Bluebunch wheatgrass was the most productive species and produced an average of 262 pounds of herbage and 38 percent of the composition on the Newdale soil but only 41 pounds of herbage and 12 percent of the composition on the Brunt soil. Thurber needlegrass was also more abundant on the Newdale soil where it produced 89 pounds of herbage and 13 percent of the composition in contrast with five pounds of herbage and one percent of the composition on the Brunt soil. Sandberg bluegrass production was about equal on the two soils with 53 pounds on the Newdale and 50 pounds on the Brunt soil. Bottlebrush squirreltail was the only grass which was more abundant on the Brunt soil. It produced 59 pounds of herbage and 18 percent of the composition on this soil which was considerably more than the three pounds of herbage and one percent of the composition on the Newdale soil. The prominence of this latter species appears to be a characteristic of Brunt soils in the area of study.

Production of forbs was consistently higher on the Newdale soil but the relative percent composition of forbs was higher on the Brunt soil because of its lower total herbage yield.

Big sagebrush produced an average of 136 pounds of herbage and 20 percent of the composition on the Newdale soil and 96 pounds per acre and 28 percent of the composition on the Brunt soil where it was the most productive species.

Threetip sagebrush and Douglas rabbitbrush were slightly more productive on the Newdale soil but were not important on either soil. There was a small amount of plains pricklypear on the Brunt soil but it was absent on the Newdale soil. Annuals were relatively unimportant on either soil.

Size and Growth Habit

On the Newdale soil, bluebunch wheatgrass plants averaged four to five inches in diameter, had leaves eight to eleven inches long and seedstalks 16 to 20 inches in height. On the Brunt soil, these plants averaged only two to three inches in diameter, leaves were five to seven inches long and seedstalks were 14 to 16 inches in height. Very few wheatgrass plants produced seedstalks on the Brunt soil. Thurber needlegrass plants were also larger and thriftier on the Newdale than on the Brunt soil. Individual bottlebrush squirreltail plants varied in size and productiveness on both soils but averaged slightly larger and slightly more productive on the Newdale soil.

Sandberg bluegrass was the only grass which appeared to grow as thriftily on the Brunt as on the Newdale soil. Plant size, leaf length, number of inflorescences and height of inflorescences were comparable for this species on the two study locations.

Forbs were only slightly larger on the Newdale soil and their greater yield on that soil was the result of larger numbers of plants rather than size of plants.

Mature big sagebrush plants averaged 30 inches in height and occasional plants reached 50 inches on the Newdale soil. These plants were much taller than broad, they had several main stems and the branches and twigs were long and slender. In contrast, the big sagebrush plants on the Brunt soil averaged only 24 inches in height and individuals seldom exceeded that height by more than a few inches. Most plants were as broad as tall, had few stems and their branches and twigs were short and stout. Big sagebrush plants on the Brunt soil appeared to be somewhat stunted in comparison with those of similar age on the Newdale soil.

Big sagebrush plants were approximately the same age on both study locations. Stems with 85 annual growth rings were recorded on the Newdale soil and plants with 82 rings on the Brunt soil. Some plants on both locations appeared to be even older but accurate ring counts could not be made because of extensive splitting and partial decay of their lower stems. Many old, partly decayed big sagebrush stems on the ground at both locations indicated that the area has not been burned for perhaps 100 years or longer.

Plant Roots

Bluebunch wheatgrass and Thurber needlegrass roots reached a depth of 48 inches and were common at depths above 36 inches in the Newdale soil. Big sagebrush roots occurred throughout the profile and were still present at the bottom of the pit at a depth of 72 inches in this soil. Roots of Sandberg bluegrass and the forbs were concentrated in the upper 12 inches of the profile and bottlebrush squirreltail roots reached a depth of 24 inches in the Newdale soil.

In contrast, most plant roots were confined to the upper 14 inches of the solonetzic Brunt soil. Very few grass roots penetrated beyond the fine textured B2 horizon of this soil. Bottlebrush squirreltail roots were observed to a depth of 20 inches but most were above 14 inches.

Roots of big sagebrush were observed to run horizontally along the top of the B2 horizon on the Brunt soil, often for several inches, before they continued downward. Big sagebrush roots were compressed and flattened where they passed through the B2 horizon. An occasional sagebrush root was observed to a depth of 72 inches in this soil.

Mulch

Differences in total herbage production on the two soils are reflected in differences in the amount of mulch. There was an average of 1473 pounds of mulch per acre on the Newdale soil and only 789 pounds per acre on the Brunt soil.

Discussion

Because there are no significant differences in climate, slope, exposure or past use between the two adjacent study locations, it can be assumed that plant differences must be associated with edaphic factors.

The much shallower depth of leaching within the Brunt soil (14 inches) as compared with that of the Newdale soil (26 inches) indicates that moisture penetration is more limited and that soil moisture available to plants at depths below 14 inches is less than in the Newdale soil. Higher pH values below depths of 20 inches in the Brunt soil suggest a higher concentration of sodium salts which would adversely affect the moisture relationship for plants growing in this soil.

The slowly permeable B2 horizon of the Brunt soil, its dispersed soil surface crusts and the physical evidence of repeated freezing and thawing in the upper horizons indicate that this soil has a temporarily supersaturated A horizon early in the spring. As indicated by Anderson (1947), this supersaturated condition is conducive to increased surface runoff of moisture and to increased evaporation from the soil surface which, together, would result in a loss of potential moisture available for plant growth.

As compared with the Newdale soil, it appears that plant growth on the Brunt soil is influenced by a textural B horizon which roots penetrate with difficulty, a higher salt content, less moisture in deeper soil horizons, and less total available moisture. These factors could affect the growth of deeper rooted species such as bluebunch wheatgrass, Thurber needlegrass and big sagebrush. These same factors should have less effect on the production of Sandberg bluegrass and the common forbs of the study locations which are naturally shallow rooted and which complete their growth early in the growing season while moisture in the upper horizons of the Brunt soil is adequate. These shallow-rooted species would not be affected by the lack of moisture in deeper soil horizons where their roots do not normally penetrate. The results of the study tend to bear out the above observations.

Bottlebrush squirreltail is known to tolerate saline conditions (U. S. Forest Service, 1937). Its presence in significant amounts on the solonetzic Brunt soil may be a reflection of its competitive advantage over associated grasses under conditions of high pH and low available soil moisture.

A material decrease in the amount of bluebunch wheatgrass and Thurber needlegrass and an increase in the amount of bottlebrush squirreltail might be expected under conditions of heavy grazing use on the Newdale soil. Such a change would tend to mask the difference between the vegetation of this soil and that of the Brunt soil. In this event, the vegetation would no longer be a reliable indicator of the potential plant communities of these soils but the soil itself would remain as the basis for their recognition.

Summary and Conclusions

Native plant communities of an intrazonal solonetzic Brunt soil and a zonal Brown Newdale soil on an ungrazed relict range area in southeastern Idaho were compared. Differences in herbage yield, species composition and growth habit of major plant species were related to specific soil characteristics.

Average herbage yield and species composition for a three-year period were determined by plot clipping and weight estimates.

With the exception of one minor species, the same plant species occurred in both plant communities. There were major differences, however, in total herbage yield and species composition.

Average herbage production was 682 pounds per acre on the Newdale soil and 337 pounds on the Brunt soil. Bluebunch wheatgrass and Thurber needlegrass were the most productive grasses on the Newdale soil but were much less important on the Brunt soil where bottlebrush squirreltail was the most productive grass. Sandberg bluegrass produced about the same on both soils. The prominence of bottlebrush squirreltail characterizes the plant community on the Brunt soil.

Deep rooted species such as bluebunch wheatgrass, Thurber needlegrass and big sagebrush were larger and more productive on the Newdale soil. There was little difference in size of Sandberg bluegrass, bottlebrush squirreltail and forbs on the two soils.

As compared with that of the Newdale soil, plant growth and species composition on the Brunt soil appeared to be influenced by a strong B2 soil horizon which restricted root penetration, a temporarily supersaturated A horizon, a higher salt content, less moisture in deeper soil horizons and less total available moisture. These factors affected the growth of deeper rooted and later maturing species more than that of shallow-rooted and early maturing species.

Changes in species composition and plant vigor which would result from heavy grazing of the natural plant community of the Newdale soil would mask the difference between this community and that of the Brunt soil. In such instance, soil characteristics would remain as a reliable basis for range site determination but vegetation would be unreliable.

Range site determinations on areas where plant communities have been altered by disturbance should be based on the relatively permanent environmental factors of soil and climate.

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A Blackbrush Over 400 Years Old

A specimen of blackbrush (*Coleogyne ramosissima* Torr.) with a comparatively large stem was collected in Dark Canyon in San Juan County, Utah. The plant was approximately 3 feet tall. A sector consisting of only about 1/5 of the original stem was obtained, the major portion having decomposed or broken away. In this sector 393 growth rings were counted. A radial growth rate of 0.49 mm. per year was determined. The central portion of the stem was missing, and observation of the curvature of the growth rings and the positions of the rays indicate that perhaps 40 or 50 growth rings had been lost. The plant was, therefore, well over 400 years old. *Earl M. Christensen and Raymond C. Brown.*