

# Some Soil-Plant Relationships in Eastern Oregon

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Soil and plant technicians, ranchers and farmers have long recognized the fact that soil differences are often accompanied by certain plant differences. Scientists have studied and written about precise soil-plant relationships. H. L. Shantz (1911, 1938) and A. W. Sampson (1939) contributed much to the understanding of plants and the soils on which they grow over a wide area, and to the application of these facts to western agriculture.

In studying soil-plant relationships, a phase of a soil type is the unit of soil mapping about which the greater number of precise statements and predictions can be made concerning soil use, management and productivity. Locally, and on arable lands, these specific soil-plant relationships are well known and recognized. On non-arable lands, the concepts of soil-plant relationships are often general in nature; as, for example, that salt-grass occurs on saline soils and conifers on acid soils. This is due to the longer and more detailed background of research and observation on cultivated lands than on range and forest lands.

## The Study Area

A study of range sites, their soils, original vegetation, and response to grazing use in eastern Oregon, has revealed some significant soil-plant relationships that have not been commonly known. To illustrate, the Columbia Basin Area of northeastern Oregon has been selected as an example. This area is bounded on the east and south by the Blue Mountains, on the west by the Cascades, and on the north by the Columbia River. Figure 1 is a north-south profile section of this Area.

From the north at the Columbia River at an elevation of about 300 feet and extending south for about 10 miles is a low rolling terraced area sloping toward the river. Farther south for about 15 miles is an area of low undulating hills somewhat higher in elevation. From here on south for another 25 miles, the drainage pattern becomes more pronounced with elevations rising to about 4,000 feet where the Blue Mountain timbered area begins.

Average annual precipitation along this profile ranges from about 7 to 8 inches at Irrigon on the river to about 16 inches near the timber.

## Soils

The general soils pattern is shown in Figure 1. The area nearest the Columbia River is characterized by Rupert sand, a soil de-

veloped in alluvium that has been reworked by wind. The undulating hills are represented by the Ritzville silt loam, a soil developed from eolian deposits. The foothill area to the south is characterized by areas of Condon silt loam and Morrow silt loam, which are primarily derived from loess with minor residual characteristics from basalt.

Typical of zonal soils, the soils representing this land profile reflect the influence of the active factors of soil genesis—climate and living organisms, chiefly vegetation. Three great soil groups,<sup>1</sup> Sierozem, Brown, and Chestnut,<sup>2</sup> are represented by these soils. They reflect improving climatic factors for plant growth.

## Vegetation

The concurrent development of soil profile and vegetation, each

<sup>1</sup>Persons unfamiliar with the concepts of great soil groups will find them defined and discussed in the 1938 Yearbook of Agriculture SOILS AND MEN.

<sup>2</sup>Improvements in the soil classification system being currently developed may somewhat change the present classification of certain soil series mentioned in this paper.

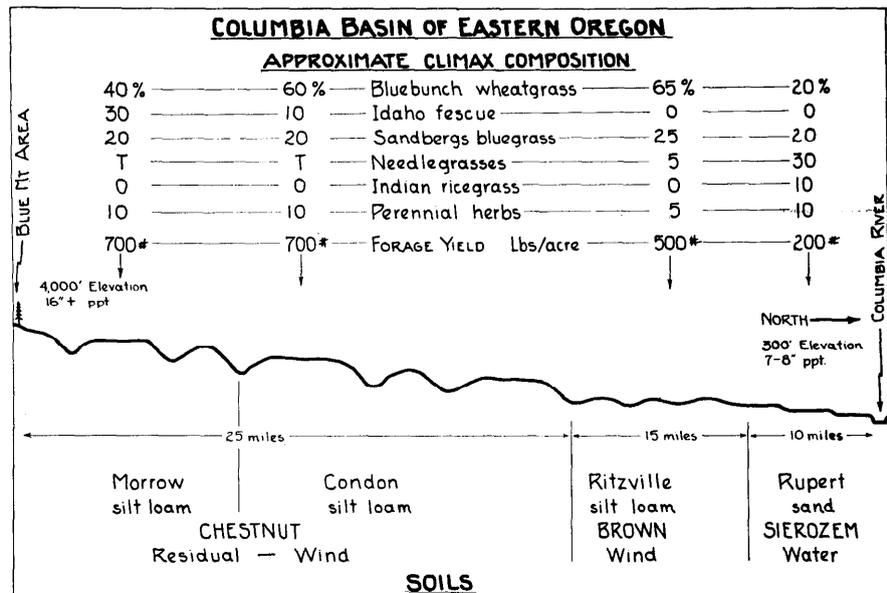


FIGURE 1. General north-south profile section of the Columbia Basin Area of Eastern Oregon showing general soil-plant relationships as influenced by changing soils, elevation, precipitation, geographic position and other climatic and physiographic factors.

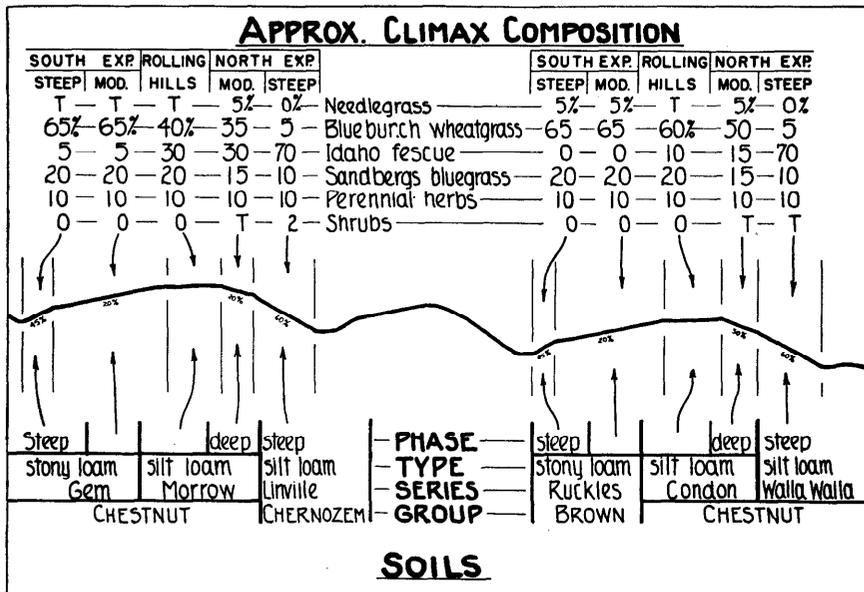


FIGURE 2. A section of the Condon-Morrow soil area of the Columbia Basin profile. Soil plant relationships as influenced by soils, exposure and slope are shown in detail comparable to actual field mapping conditions.

with its reciprocal influence on the other, is illustrated for this land profile in Figure 1.

Typical plant communities and climax compositions are shown for the normal relief of each soil where the influence of exposure is at a minimum. In the climatic situation represented by the Rupert soil area, needlegrasses (*Stipa occidentalis*, *S. comata*) predominate in the climax composition. As the situation for plant growth improves as a result of changes in soils, elevation, precipitation, geographic position, and other climatic and physiographic factors as represented by the Ritzville soil area, needlegrasses are largely replaced in the climax composition by bluebunch wheatgrass (*Agropyron spicatum*). With additional improvement of conditions for plant growth as represented by the Condon soil area, Idaho fescue (*Festuca idahoensis*) enters the climax composition. Still further improvement of conditions for plant growth, as represented by the Morrow soil area, results in an increasing replacement of bluebunch wheatgrass by Idaho fescue in the climax composition.

The percentage of perennial herbs in the composition changes

very little but the species are markedly different under each of the different situations.

#### Yields

Potential forage yields increase as climatic conditions for plant growth improve from the Rupert to the Ritzville and Condon soil areas. The lack of yield increase from the Condon to the Morrow soil area results from the lower growth-form of Idaho fescue as compared to bluebunch wheatgrass. The increased occurrence of a lower forage producing species is about equalized, in terms of forage production, by an increase of stand density, and both areas produce about the same.

#### Great Soil Groups and Range Sites

Because of significant differences in kind and amount of climax vegetation, the normal relief of Rupert soil is a different range site than that of Ritzville soil. Likewise, the normal relief of Ritzville soil is a different range site than the Condon soil. But the differences in climax composition between the normal reliefs of Condon and Morrow soils represent the lower and upper phases of the same range site. Such variations within a

range site are referred to by Poulton (1955) as habitat types. A separate range site on similar rolling topography would be recognized when conditions for plant growth resulted in an Idaho fescue dominance in the climax composition.

Corresponding differences in soils are closely related to these vegetal differences. The Rupert, Ritzville and Condon soils have profile characteristics sufficiently different to classify them into different great soil groups. The Condon and Morrow soils have profile characteristics sufficiently similar to classify them in a single great soil group.

An apparent principle of soil-plant correlation indicated by our study is this: In range areas having zonal soils—which are soils that reflect the influence of environment in their profile development—when environmental forces are sufficiently different between two areas to produce soils representative of two great soil groups, the accompanying climax vegetation is significantly different in kind and amount and different range sites are involved. Present indications are that great soil groups of Intrazonal and Azonal soils—which are soils that reflect the influences of environment in their profile characteristics to a lesser degree—also have significant soil-plant relationships that can be identified and are locally consistent.

The relationship between significantly different kinds and amounts of climax vegetation and the soils on which they occur is more specifically illustrated in Figure 2, which represents a section of the Condon-Morrow soil area of the Columbia Basin. The detail of soil delineation represented on this profile is comparable to actual field mapping in this area.

Consider the right-hand portion of the profile in which the Condon silt loam occupies a rolling hill position. On the moderate north exposure the soil is typically deeper than on the rolling hills and it

is classed as a deep phase of Condon silt loam. On the steep north exposure, the characteristics of the soil are such that it is called a different series, Walla Walla. And since the normal phase of Walla Walla silt loam is on an undulating topography, this is called a steep phase. On the south exposure, the soil differs sufficiently from the Condon soil to be a different series, the Ruckles. A steep phase of the Ruckles stony loam is mapped on slopes exceeding 40 percent.

Consider the left side of Figure 2 in which Morrow silt loam occupies the rolling hills position. It will be noted that the same pattern exists as in the Condon soil area, but different soil series are involved.

In the Condon soil area, environmental influences of south exposures on soil profile development have been such that the Ruckles soil is classified in the Brown great soil group, instead of in the Chestnut as are the Condon and Walla Walla. By contrast, in the Morrow soil area, environmental influences of south exposures on soil profile development have been such that the Gem is classified in the Chestnut great soil group along with the Morrow. The Linville<sup>3</sup> on the steep north exposure, however, is classified as a Chernozem.

In the Condon soil area, the major change in the climax vegetation consistent with soil changes is in the amount of Idaho fescue and bluebunch wheatgrass in the climax composition. As conditions for plant growth change from the rolling hills to the steep north exposure, Idaho fescue replaces bluebunch wheatgrass. But the reverse is true as the conditions for plant growth change toward the south exposure. This same pattern occurs in the Morrow soil area, except that Idaho fescue persists in the climax composition on the south exposure.

A south exposure with Gem soil produces Idaho fescue in the cli-

<sup>3</sup>The Linville series is tentative and has not been correlated.

APPROX. CLIMAX COMPOSITION			
NORTH EXPOSURE		NORTH EXPOSURE	
35-50%	Bluebunch wheatgrass	5-15%	
15-35	Idaho fescue	60-70	
15	Sandbergs bluegrass	10	
5	Needlegrass	0	
10	Perennial herbs	10-15	
T	Shrubs	T-2	

SLOPE		SLOPE	
Linville silt loam			
deep		25-45%	
mod. deep		25-55	
Morrow silt loam			
mod. deep	5-25%	25-40%	
shallow	10-30	30-50	
Walla Walla silt loam			
deep		30-55%	
mod. deep		30-60	
Condon silt loam			
deep	10-15%		
mod. deep	10-30	30-40%	
shallow	10-40	40-50	

FIGURE 3. Effect of soil depth and climatic influences as represented by degree of slope on the climax compositions of north exposures in the Condon-Morrow soil area of the Columbia Basin.

max composition. This, together with corresponding differences in kinds and amounts of other plants, qualifies it as a range site separate from a south exposure with Ruckles soil. Gem is classified in the Chestnut and Ruckles in the Brown great soil groups.

As previously pointed out, the normal relief of Condon and Morrow soils represent the lower and upper phases of the same range site and are different habitat types. Both soils are classified in the Chestnut great soil group.

The steep north exposures with both Linville and Walla Walla soils produce essentially the same climax composition and are the same range site but the Linville is presently classified in the Chernozem and the Walla Walla in the Chestnut great soil groups. Recognizing that the Walla Walla silt loam normal phase is on an undulating topography, possibly soils on steep north exposures should not be classified as Walla Walla, but as some other series in the Chernozem great soil group.

Other examples indicate that the Chestnut great soil group is entirely too broad in its range to correlate well with vegetation changes and the Chernozem is too narrow. Certain soil series could

be grouped in a more logical manner if the Chernozem group were re-defined to include the upper portion of the Chestnut group. The climax vegetation and certain dryland cropping characteristics support this suggestion. These very apparent indicators can be used as a basis for analyzing and adjusting the soil classification system. The concept of soil-plant relationships would be strengthened.

**Effects of Slope and Soil Depth on Plant Composition**

A more specific example of soil-plant relationships is given in Figure 3 which illustrates the effect of soil depth and degree of slope on climax composition. This correlation is most pronounced on north exposures in the Columbia Basin. The soils of the north exposures in Figure 2 are used in this illustration.

The Linville silt loam and the Walla Walla silt loam, both on north exposures, have been mapped with two depth classes each. Both depth classes are associated with Idaho fescue dominance in the climax composition.

Moderately deep Morrow silt loam on north exposures produces a dominance of bluebunch wheat-

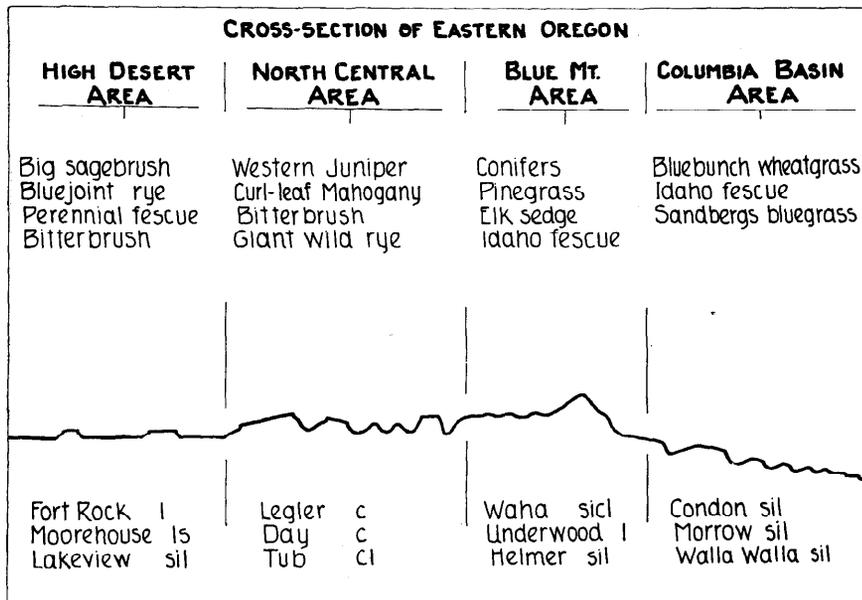


FIGURE 4. Profile cross-section from Washington on the north (right) to Nevada on the south showing broad correlations that exist between soils and vegetation as related to the natural subdivisions of Eastern Oregon.

grass on slopes up to 25 percent and a dominance of Idaho fescue on slopes over 25 percent. When this soil is shallow, a north exposure slope of 30 percent is required to cause a change from bluebunch wheatgrass to Idaho fescue dominance.

Condon silt loam on north exposures has three depth classes. The deep class occurs on slopes less than 15 percent and produces a bluebunch wheatgrass dominance. A 30 percent north exposure slope when moderately deep, and 40 percent when shallow, is required to cause a change from bluebunch wheat grass to Idaho fescue dominance in the climax composition. The shallower depth classes for each soil occur on the steepest slopes.

The actual percent slope at which these significant changes take place does not necessarily occur in 5 percent increments. In mapping range lands the slope is estimated to the nearest 5 percent.

These data are based upon 396 separate samples of north exposures and are a portion of a range site analysis involving 72 ranches representing over 400,000 acres in the Columbia Basin of eastern Oregon.

#### Natural Subdivisions of Eastern Oregon

The discussion so far has illustrated soil-plant relationships ranging from those of a general and commonly known character to those of a specific and less known character, all within the relatively homogeneous area of the Columbia Basin. Equally important in the art and science of arable and non-arable land management are the broader correlations that exist between soils and vegetation. Figure 4 illustrates some of these correlations in a cross-section of eastern Oregon. Each of the natural subdivisions of eastern Oregon represented here has identifying characteristics of soils, vegetation, topography, geology and climate that affect the entire field of agriculture within that area.

The Columbia Basin Area is typified by a characteristic topographic pattern, by three grasses—bluebunch wheatgrass, Idaho fescue and Sandberg bluegrass (*Poa secunda*)—that make up a high percentage of the climax composition on each grassland site, and by such soils as Condon, Morrow and Walla Walla silt loam.

The higher Blue Mountain Area is typified by its extensive stands

of coniferous trees and such forage plants as pinegrass (*Calamagrostis rubescens*), elk sedge (*Carex geyeri*) and Idaho fescue, together with such soils as Waha silty clay loam which produces an open grassland, Underwood loam which produces ponderosa pine grassland, and Helmer silt loam which produces a mixed fir forest.

Farther south the rugged topography resulting from terrific folding, lifting, faulting, and volcanic action plus geologic erosion of deep sedimentary deposits, makes the North Central Area one of spectacular physiography. Mahogany- and juniper-covered buttes capped with igneous or sedimentary rocks are in contrast to the rounded topography of the eroded sediments of lower elevations. The widespread invasion of juniper (*Juniperus occidentalis*) indicates its affinity for the highly calcareous fine-textured soils derived from these ancient sedimentary deposits as typified by the Legler clay, the Day clay, and the Tub clay loam.<sup>4</sup> Bitterbrush (*Purshia tridentata*) is important in this area and the plant occurs on most upland sites. Giant wild-rye (*Elymus cinereus*), associated only with bottomlands in some other areas, occurs uniformly in the climax on upland sites. Possibly this is because of the increased lateral drainage in these fine textured soils, which also results in profuse springs and seeps.

That portion of the Great Basin lying within Oregon with its relatively flat lakebed appearance and its interior drainage is widely known as the High Desert Area. It, too, has characteristic plants and soils setting it apart from other eastern Oregon areas. The uniform occurrence of big sagebrush (*Artemisia tridentata*) over nearly all sites and its apparent place in climax compositions is typical. Bluejoint wild-rye (*Elymus triticoides*) occurs extensively on ancient lakebed sites. Bitterbrush occurs uniformly on the upland sites.

<sup>4</sup>The Legler, Day and Tub soils are tentative and have not been correlated.

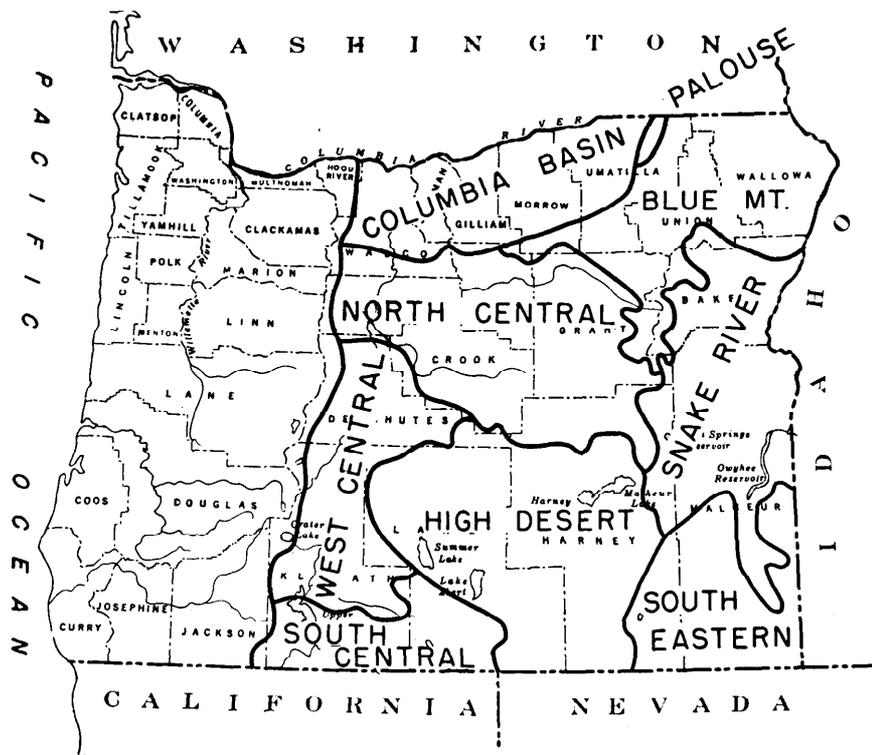


FIGURE 5. General location and extent of the natural areas of Eastern Oregon. Field delineation of these areas is recorded on detailed maps of the region and is based on soil-plant relationships determined by field study.

Here too, occurs a perennial fescue that keys out as Idaho fescue but has an opposite response to effective moisture levels and is surely an ecotype of distinctive character. These plant characteristics are typically associated with such soils as the Fort Rock loam on the diatomaceous sediments, the

Moorehouse loamy sand on the sand hills, and the Lakeview silt loam on lakebeds.<sup>5</sup>

These broadly homogeneous natural subdivisions of eastern Oregon

<sup>5</sup>The Fort Rock, Moorhouse and Lakeview series are tentative and have not been correlated.

are not just areas of relative location. Like individual soils and plant communities, they can be delineated, as shown in Figure 5. If their broad soil-plant relationships are as outstandingly consistent within the areas and as different from adjacent natural areas as they appear to be, then it seems reasonable that any sound agricultural program must recognize these areas.

Since these natural areas and the specific soil-plant relationships within them do not coincide with political boundaries, educators and technicians—soils, range, agronomy and forestry—working with agriculture in soil conservation districts, grazing districts, state or national forests, or in counties and even in different states, need to recognize and understand these basic facts about ecology.

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