INTRODUCTION
There are at least 28 species of sagebrush, and many more subspecies or varieties, found in the Intermountain West. All belong to the genus *Artemisia*. This Special Publication will focus on the woody sagebrush species found in Nevada, which provide important habitat and forage for wildlife and domestic livestock. These include:

- **Basin big sagebrush** (*Artemisia tridentata* ssp. *tridentata*)
- **Wyoming big sagebrush** (*A. t*. ssp. *wyomingensis*)
- **Mountain big sagebrush** (*A. t*. ssp. *vaseyana*)
- **Black sagebrush** (*A. nova*)
- **Low sagebrush** (*A. arbuscula*)
- **Lahontan sagebrush** (*A. arbuscula* ssp. *longicaulis*)
- **Alkali or early sage** (*A. longiloba*)
- **Three-tip sagebrush** (*A. tripartita*)
- **Silver sagebrush** (*A. cana*)
- **Fringed sagebrush** (*A. frigida*)
- **Bud sagebrush** (*A. spinescens*)
- **Pygmy sagebrush** (*A. Pygmaea*)

Many sagebrush species often look similar to each other but they usually have different canopy sizes, canopy shapes, and leaf size and shape. Also, they grow on different landforms and soils; therefore, they inhabit different parts of the landscape. The specific species that inhabits a site is determined by interactions among soil texture (sand, silt, clay), soil depth, soil water holding capacity, average precipitation run-on moisture (water transported onto a site), the potential for prolonged flooding, and soil chemistry (e.g., salt content).

GENERAL TAXONOMIC TERMS AND DEFINITIONS
Sagebrush leaves usually have tips that are divided into distinct segments (e.g., lobes). These segments often have different shapes (e.g., lobes, linear, threadlike). Also, the depth of the division between the segments is different among some species. Counting the number of segments, and knowing the shape of the individual segments and the depth of the divisions between segments, helps identify the sagebrush species or subspecies. This section identifies and defines important terms related to the shape of sagebrush leaves, and the depth of the divisions between leaf segments. Information about leaf length is found in the descriptions for each species or subspecies of sagebrush.
• **Lobes** are shallow rounded divisions at the tip of the leaf.
• **Points or barbs** refer to leaf tips with sharp or acute points. They are not rounded.
• **Linear** leaves or leaf segments have a long, narrow shape. Their length is much longer than their width, and they have essentially parallel sides. They resemble a “wide” line.
• **Threadlike** refers to leaves or leaf segments that are long and very thin, much like sewing thread.
• **Shallow divisions** means the depth of the division is less (usually much less) than one-half the length of the leaf.
• **Deep clefts** are divisions between leaf segments that are at least one-half the length of the leaf.

Taxonomic terms defined above are highlighted (bold, italics, and underlined) when used in the following text.

**BIG (TALL) SAGEBRUSH, WITH THREE ROUNDED **LOBES** AT THE LEAF TIP**

Three subspecies of big sagebrush grow in Nevada: basin big sagebrush, Wyoming big sagebrush, and mountain big sagebrush. Each subspecies is capable of growing to 40 inches tall or more. Mountain big sagebrush and Wyoming big sagebrush always have leaves with three rounded **lobes** at the tip of the leaf. Most leaves on basin big sagebrush have three **lobes**, but occasionally some leaves are without **lobes**, or are variably **lobed**. All three subspecies are evergreen, and like all sagebrush species, except bud sagebrush, have gray-green leaves. None sprout after the canopy has been removed.

**Basin big sagebrush** is the tallest of the big sagebrush subspecies. Mature stands typically have plants that exceed 3 ft to 4 ft fall, and some plants may be over 10 ft tall. The shrub canopy has a rounded, uneven appearance, with flower stalks rising from throughout the canopy. Basin big sagebrush has the longest leaves, averaging about two-thirds of an inch.

Basin big sagebrush is common where the soil has a sandy to loamy texture, is over 3 ft deep, and does not have a subsurface restrictive layer (e.g., caliche, hardpan) that limits rooting depth. These locations may include the plains and alluvial fans located near and above the valley bottoms (4,200 ft to about 6,000 ft elevation), but between the mountain ranges. Also, it inhabits both seasonal and perennial stream channels up to about 8,200 ft elevation. Basin big sagebrush may occur in areas that receive less than 8 inches of annual precipitation, or in areas with over 16 inches of precipitation. The drier sites are occupied if they have a high infiltration rate and water storage capacity, and/or supplemental run-on moisture from adjacent areas. Seasonal stream channels receiving runoff from nearby areas are a good example. The deep porous soil acts as a sponge, increasing the amount of water available to the plant during the dry season. Basin big sagebrush does not tolerate saturated soils; therefore, it does not grow where soils are saturated for several weeks or more. Basin big sagebrush has occupied many former meadows and riparian areas where the water table has been lowered from natural or accelerated erosion. The deep roots allow it to access deeper water tables and act (function) like a water loving species.

**Wyoming big sagebrush** is the shortest of the three big sagebrush subspecies. Mature stands usually have plants from about 30 inches to 40 inches tall. Plants may be shorter on sites with very shallow or rocky soil. The canopy of Wyoming big sagebrush is shaped similar
to basin big sagebrush, but is usually shorter and not as wide. The individual leaves are much shorter, averaging about one-third of an inch long.

Wyoming big sagebrush occurs most frequently on sites that receive between 8 inches and 12 inches of precipitation. The typical elevation range is from about 4,500 ft to 6,500 ft. It may extend to higher elevations on south facing slopes or to lower elevations on north facing slopes. Wyoming sagebrush often inhabits lower mountain slopes, foothills, and valley slopes above the nearly level valley bottoms. Wyoming big sagebrush does not inhabit soils that are predominantly clays, preferring sites with roughly equal amounts of sand, silt, and clay (e.g., loamy soil). Soils are typically about 10 inches to 30 inches deep and can have large amounts of gravel and rock fragments, which reduces the water holding capacity. Wyoming big sagebrush is not common where hardpan (calcium carbonate, caliche) layers develop at shallow depths. Soils on Wyoming big sagebrush sites typically have a lower water holding capacity than soils where either basin big sagebrush or mountain big sagebrush grow. Infiltration rates can be slow or rapid, but the soil’s low water holding capacity often results in runoff that can support basin big sagebrush in nearby ephemeral (short-lived) streams, that stop running shortly after precipitation events or snowmelt. Wyoming big sagebrush can provide important cover for many wildlife species, as well as winter forage for sage grouse and mule deer.

Mountain big sagebrush can grow to over 40 inches tall on deep soils, where deep snow accumulates. On mountain slopes where snow is blown off or melts quickly, mountain sagebrush is much shorter. Mountain sagebrush typically has a distinct flat-topped canopy, with most flower stalks emerging from the top of the canopy, above the foliage. Its leaves are about the same length as basin big sagebrush, but are widest at the base of the leaf’s lobes (i.e., near the tip), not toward the leaf’s center.

Mountain big sagebrush is a high elevation, high precipitation sagebrush. It is almost always restricted to elevations above about 6,000 ft, and/or areas where the annual precipitation exceeds 12 inches. Mountain big sagebrush may occur where the actual precipitation is less than 12 inches if substantial amounts of windblown snow accumulate (e.g., north facing slopes below ridgelines). Mountain sagebrush inhabits mountain sideslopes and drainages, and high elevation valley bottoms, where the soil usually is from 18 inches to over 36 inches deep and well drained. Preferred sites have a loamy soil, but also can have substantial amounts of clay. Gravel and rock fragments can be abundant. Salts and carbonates are usually absent or present in trace amounts. At higher elevations mountain sagebrush can grow in almost pure stands, but is commonly associated with other shrubs and trees.

Of the three big sagebrush species, basin big sagebrush generally is the least preferred forage species. Mountain big sagebrush often has the highest digestibility, but is not necessarily the most preferred subspecies. Research has shown that the same species of big sagebrush at different locations, or different individual plants at the same location, can have very different plant chemistries. This influences the degree of use as forage. Plants with high levels of essential oils, monoterpenes, tannins, and other chemicals are used less than plants with low levels of these chemicals.
SHORT SAGEBRUSH, WITH THREE-LOBED LEAVES

Black sagebrush, low sagebrush, and alkali sagebrush typically are much shorter than big sagebrush. Lahontan sagebrush typically is shorter than the big sagebrush subspecies, but it can be up to three feet tall. All four plants are evergreen and do not sprout after the canopy is removed.

**Black sagebrush** is generally 12 inches tall or shorter, with leaves less than one-half inch long. This species flowers in the fall, and the flower stalks often cast a slight orange appearance. These flower stalks often persist from year to year. The canopy is often loosely branched with a short trunk, but may have a compact rounded appearance if heavily grazed by wildlife or livestock. The stems are usually dark, and the leaves have tiny black dots, hence the name black sagebrush.

Black sagebrush is found on sites from about 4,500 ft to 8,500 ft, where the annual precipitation ranges from less than 8 inches to over 16 inches. Black sagebrush is often found on gentle slopes above the nearly level valley bottoms, the adjacent foothills, and on steep mountain sideslopes. The primary factors that control its distribution are a soil with a low water holding capacity and usually a high level of calcium carbonates. Black sagebrush typically inhabits soils that have either bedrock or a caliche (thick calcium carbonate that restricts rooting depth) layer at about 18 inches or less. It tolerates large amounts of soil carbonates better than the other sagebrush species. It is common on shallow soils derived from limestone. Soil profiles often have substantial amounts of gravel or rock that further limit the soil’s water holding capacity. Black sagebrush does not tolerate prolonged flooding, preferring to inhabit drier sites. Black sagebrush provides important forage for pronghorn, mule deer, sage grouse, and domestic sheep, particularly in the late summer, fall, and winter, when succulent forbs and grasses decline. Cattle may increase consumption of the plant in the fall and winter.

**Low sagebrush** is usually between 4 inches and 12 inches tall, but has shorter leaves (0.3 inches or less) than black sagebrush. The leaves have a fairly distinct gray-green color, and lack the tiny black dots found on black sagebrush. The canopy is usually mounded, dense, and often has multiple stems (trunks) emerging from the soil.

Low sagebrush grows from about 5,000 ft to nearly 11,000 ft. Similar to black sagebrush, low sagebrush inhabits shallow soil and does very well where the soil has a high content of gravel and/or rock. Unlike black sagebrush it grows on soils with high clay content, and/or a claypan at shallow depths. Low sagebrush is not well adapted to soils with a high content of carbonates. Landforms typically inhabited are the shoulders and summits of windblown ridges; steep windblown mountain slopes with shallow soil and high rock content; rolling foothills with shallow, rocky soil; and mesas, buttes, and mountain summits with shallow rocky soil and high clay content. Low sagebrush is fairly well adapted to soils that remain saturated for several days or more during snowmelt. This species is palatable for numerous species of wildlife, including pronghorn antelope, mule deer, and sage grouse. Sheep and cattle may use it extensively.

**Lahontan sagebrush** is a subspecies of low sagebrush. The shape of the canopy closely resembles low sagebrush, but it is taller and wider, and has more erect flower stalks. Also, the leaves are larger than those on low sagebrush.

Lahontan sagebrush occurs on about one-half million acres in northwest Nevada, northeastern California, and southeastern
Oregon, at elevations between about 3,500 ft and 6,500 ft. One of the centers of its distribution are old shorelines of Pleistocene Lake Lahontan. It often occurs in pure stands, but can co-occur with basin big sagebrush, Wyoming big sagebrush, low sagebrush, and black sagebrush.

Lahontan sagebrush has been found on at least 17 different soil series. Common characteristics among these soils are a low water holding capacity and shallow depth to a clay layer or bedrock. These are characteristics common on sites inhabited by low sagebrush.

Forage preference for Lahontan sagebrush is moderate to high. Its elevation range overlaps the fall, winter, and early spring grazing areas for many wild and domestic animals. Many shrubs show evidence of browsing. Domestic sheep, mule deer, and antelope have been reported to readily use this plant.

Alkali sagebrush is very similar to low sagebrush for plant and leaf size. The three-lobed leaves, however, have deep clefts. Clefts are divisions between the lobes that are about one-half or more the length of the leaf. Alkali sagebrush typically inhabits soils with a higher alkaline content. These soils are often derived from shale or limy parent materials. The elevation range for alkali sagebrush is between 5,900 ft and 8,000 ft. Alkali sagebrush often blooms in mid-June to mid-July, about 1 to 2 months earlier than the other 3-lobed sagebrush species.

Silver sagebrush is typically between 15 inches and 40 inches tall. It occurs from about 5,000 ft to almost 11,000 ft throughout the sagebrush region of Nevada. Silver sagebrush is largely restricted to moist soils in meadows, streambanks, and bottomlands. These soils often have a high silt or clay content, and their drainage is poor to slow. Silver sagebrush withstands flooding better than black sagebrush and the big sagebrush subspecies. The leaves are 1-2 inches long, thin, and deciduous. Each leaf may or may not have 2 to 3 narrow points (tips or barbs) at its endpoint. These leaf tips are not rounded lobes, like those in the big sagebrush subspecies, but are sharp points, with very shallow (short and somewhat broad) divisions between the points. Silver sagebrush is one of few sagebrush species that spreads by underground roots (rhizomes), and it can sprout after a fire.

SHORT SAGEBRUSH, WITH SMALL LEAVES: leaves have three or more deep clefts with narrow segments

Both fringed sagebrush and bud sagebrush fit this description. Both grow in
locations with droughty soils, but can be easily identified by differences in their leaf shape, leaf color, and leaf longevity.

**Fringed sagebrush** is a short, mat forming species, with erect stems that approach 15 inches tall. The stems are often white because of many fine hairs.

Fringed sagebrush is most common in central and southern Nevada, ranging in elevation from about 4,500 ft to almost 11,000 ft, but usually is located at low to mid elevations. Fringed sagebrush typically inhabits valley plains and foothills where the soil is droughty and total plant abundance is low. Fringed sagebrush does not spread by rhizomes or roots and does not sprout after a fire. The leaves are small (0.2 inches to 0.5 inches long), numerous, and often **deeply** divided into 2-3 **threadlike** segments. Each segment is less than 0.05 inches wide, but has a length about one-half or more of the leaf. Also, the leaves are covered by long, thin (fine) hairs.

**Bud sagebrush** is a short (4 inches to 20 inches tall), spiny plant found between about 2,300 ft and 6,800 ft. At higher elevations, it usually is found on south facing aspects. Bud sagebrush is widespread but monocultures are very rare. It is the most drought tolerant sagebrush and often grows where soils are saline. It inhabits salt desert shrub communities and the lower elevation range of the basin big sagebrush, Wyoming sagebrush, and black sagebrush community types. The leaves are deep green, up to three-quarters of an inch long, and have 3-5 **deep**, narrow **clefts**. Each division is about one-half the length of the leaf. The leaves are deciduous and usually drop to the ground by midsummer. Bud sagebrush is readily grazed in the spring by wildlife and livestock.

**VERY SHORT SAGEBRUSH WITH VERY SMALL, DENSE PINNATE LEAVES**

Pinnate leaves have two rows of leaflets on both sides of a central axis. The physical arrangement of the leaf resembles a feather (i.e., hairs on opposite sides of a quill).

**Pygmy sagebrush** is the only sagebrush species in Nevada that fits this category. The typical plant height is between 4 inches and 8 inches tall. The leaves are evergreen and usually between 0.1 inch and 0.3 inches long. Each leaf has between 4 and 11 individual leaflets.

Pygmy sagebrush typically inhabits valley bottoms and shallow slopes below the mountains. Soils are dry, calcareous or saline, and high in clay content. Pygmy sagebrush does not form extensive stands and in Nevada is restricted to the east-central part of the state. Throughout the Great Basin it is believed to occupy less than about 12,500 ac.

**SEED PRODUCTION**

Seed production has not been well researched for all sagebrush species; however, all of the species and subspecies discussed are capable of producing large quantities of seed per plant. For big sagebrush one study found the average stand could produce 20 million seed per acre annually. Seed production declines dramatically in mature stands that have a large amount of woody biomass and sagebrush canopy cover above 15% to 25%. Thinning mature stands increases the number of seed stalks per plant, potentially increasing total seed production. There is substantial variation in seed production between years and between stands, due to climatic and genetic variation, differences in stand maturity and canopy cover, and differences in the soil’s water holding capacity.

**SEED DISPERSAL**

Sagebrush seed has very poor dispersal. It lacks appendages for airborne
transport by the wind, or for attachment to animals. Most seed falls beneath the plants and moves 3 ft or less per generation.

BIBLIOGRAPHY


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Appendix 1. Summary of the general plant, soil, topographic, climatic, and landscape location characteristics of the woody sagebrush species known to occur in Nevada. Exceptions to each parameter can be found. Values and descriptions presented are for typical plants or species.

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin Big Sagebrush</td>
<td>3 shallow lobes</td>
<td>0.66</td>
<td>36 to 48</td>
<td>No</td>
<td>36+</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Wyoming Big Sagebrush</td>
<td>3 shallow lobes</td>
<td>0.33</td>
<td>30 to 40</td>
<td>No</td>
<td>10 to 30</td>
<td>No</td>
<td>Very Seldom</td>
<td>No</td>
</tr>
<tr>
<td>Mountain Big Sagebrush</td>
<td>3 shallow lobes</td>
<td>0.66</td>
<td>30 to 40</td>
<td>No</td>
<td>18 to 36+</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Black Sagebrush</td>
<td>3 shallow lobes</td>
<td>0.50</td>
<td>≤ 12</td>
<td>No</td>
<td>&lt; 18</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Low Sagebrush</td>
<td>3 shallow lobes</td>
<td>0.33</td>
<td>4 to 12</td>
<td>No</td>
<td>&lt; 18</td>
<td>Yes</td>
<td>No</td>
<td>For several weeks</td>
</tr>
<tr>
<td>Lahontan Sagebrush</td>
<td>3 shallow lobes</td>
<td>0.50</td>
<td>≤ 30 to 36</td>
<td>No</td>
<td>4 to16</td>
<td>Yes</td>
<td>No</td>
<td>For several weeks</td>
</tr>
<tr>
<td>Alkali Sagebrush</td>
<td>Deeply lobed</td>
<td>0.33</td>
<td>4 to 12</td>
<td>No</td>
<td>&lt; 18</td>
<td>Yes</td>
<td>No</td>
<td>For several weeks</td>
</tr>
<tr>
<td>Silver Sagebrush</td>
<td>Long, linear, with occasional 2-3 barbs 2.00</td>
<td>1.00 to 15 to 40</td>
<td>Yes</td>
<td>60+</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Three-tip Sagebrush</td>
<td>3 linear tips with deep divisions</td>
<td>1.66</td>
<td>8 to 40+</td>
<td>Yes</td>
<td>30+</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Fringed Sagebrush</td>
<td>2-3 deep divisions with threadlike tips</td>
<td>0.2 to 0.5</td>
<td>&lt; 15 mat forming</td>
<td>No</td>
<td>15+</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Bud Sagebrush</td>
<td>3-5 deep, narrow divisions</td>
<td>0.33 to 0.75</td>
<td>&lt; 18</td>
<td>No</td>
<td>&lt;18</td>
<td>No</td>
<td>Often</td>
<td>No</td>
</tr>
<tr>
<td>Pygmy Sagebrush</td>
<td>Pinnate leaflets</td>
<td>0.1 to 0.33</td>
<td>4 to 8</td>
<td>No</td>
<td>4-18</td>
<td>No</td>
<td>Sometimes</td>
<td>No</td>
</tr>
</tbody>
</table>
Appendix 1 (continued). Summary of the general plant, soil, topographic, climatic, and landscape location characteristics of the woody sagebrush species known to occur in Nevada. Exceptions to each parameter can be found. Values and descriptions presented are for typical plants or species.

<table>
<thead>
<tr>
<th>Sagebrush Species</th>
<th>General Soil Chemistry</th>
<th>General Soil Texture</th>
<th>Elevation Range (ft)</th>
<th>Precipitation Range (in)</th>
<th>General Landform / Topography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin Sagebrush</td>
<td>Non-alkaline, non-saline and non-calcareous</td>
<td>Sandy to loamy</td>
<td>4,000 to 8,000</td>
<td>8 to 16+</td>
<td>Gentle valley side slopes below foothills and mountains; seasonal stream channels and degraded meadows</td>
</tr>
<tr>
<td>Wyoming Sagebrush</td>
<td>Can be mildly alkaline</td>
<td>Loamy to silt loam; often very gravelly</td>
<td>4,500 to 6,500</td>
<td>7 to 12</td>
<td>Mid-elevation valley bottoms, gentle valley slopes; and lower foothills</td>
</tr>
<tr>
<td>Mountain Sagebrush</td>
<td>Non-saline, non-alkaline and non-calcareous</td>
<td>Loamy to clay loam; often gravelly</td>
<td>6,000+</td>
<td>12+</td>
<td>Mountain sideslopes, summits, and ridges; high elevation plateaus and valley bottoms; snow drift areas</td>
</tr>
<tr>
<td>Black Sagebrush</td>
<td>Calcareous but non-saline</td>
<td>Gravelly loam</td>
<td>4,500 to 8,500+</td>
<td>7 to 16+</td>
<td>From gentle valley slopes to steep mountain sideslopes, summits, and ridges where soil has low water holding capacity and calcareous chemistry</td>
</tr>
<tr>
<td>Low Sagebrush</td>
<td>Non-saline, non-alkaline and usually non-calcareous</td>
<td>High clay content; often very gravelly</td>
<td>5,000 to 11,000</td>
<td>&gt;10 to 12</td>
<td>Gentle valley slopes; steep mountain sides, summits, and ridges; and mesas and plateaus where soil has a low water holding capacity and high clay content</td>
</tr>
<tr>
<td>Lahontan Sagebrush</td>
<td>Non-saline, non-alkaline and non-calcareous</td>
<td>High clay content; often very gravelly</td>
<td>3,500 to 6,500</td>
<td>&lt;8 to 12</td>
<td>Lower foothills and mountain slopes, and upper slopes with dry, clayey soils and high rock content</td>
</tr>
<tr>
<td>Alkali Sagebrush</td>
<td>Alkaline</td>
<td>High clay content</td>
<td>5,500 to 8,000</td>
<td>10 to 16+</td>
<td>Low lying positions that receive run-on moisture; edges of playas or lake basins; depressions</td>
</tr>
<tr>
<td>Silver Sagebrush</td>
<td>Non-saline, non-alkaline and non-calcareous</td>
<td>Clay to silty clay</td>
<td>5,000 to 11,000</td>
<td>10+</td>
<td>Depressions or enclosed basins where water accumulates; Water table usually within 3 ft of surface</td>
</tr>
<tr>
<td>Three-tip Sagebrush</td>
<td>Non-saline, non-alkaline and non-calcareous</td>
<td>Loamy, but often high gravel content</td>
<td>3,600 to 7,500</td>
<td>10+</td>
<td>Usually mountain sideslopes with north facing aspects</td>
</tr>
<tr>
<td>Fringed Sagebrush</td>
<td>Non-saline, non-alkaline and non-calcareous</td>
<td>Sandy to loamy; gravelly</td>
<td>4,500 to 7,500</td>
<td>7+</td>
<td>Shallow depressions that collect moisture and floodwaters; 11,000 also, mountain slopes and foothills</td>
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<tr>
<td>Bud Sagebrush</td>
<td>Sometimes alkaline and saline tolerant</td>
<td>Sandy to loamy; usually gravelly</td>
<td>2,300 to 6,800</td>
<td>&lt;6 to 10</td>
<td>Valley bottoms upward to lower foothills and mountain slopes; mesas and plains</td>
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<tr>
<td>Pygmy Sagebrush</td>
<td>Sometimes alkaline</td>
<td>Clayey to sandy loam; usually gravelly</td>
<td>5,000 to 7,000</td>
<td>6 to 12</td>
<td>Gentle slopes above valley bottoms</td>
</tr>
</tbody>
</table>