

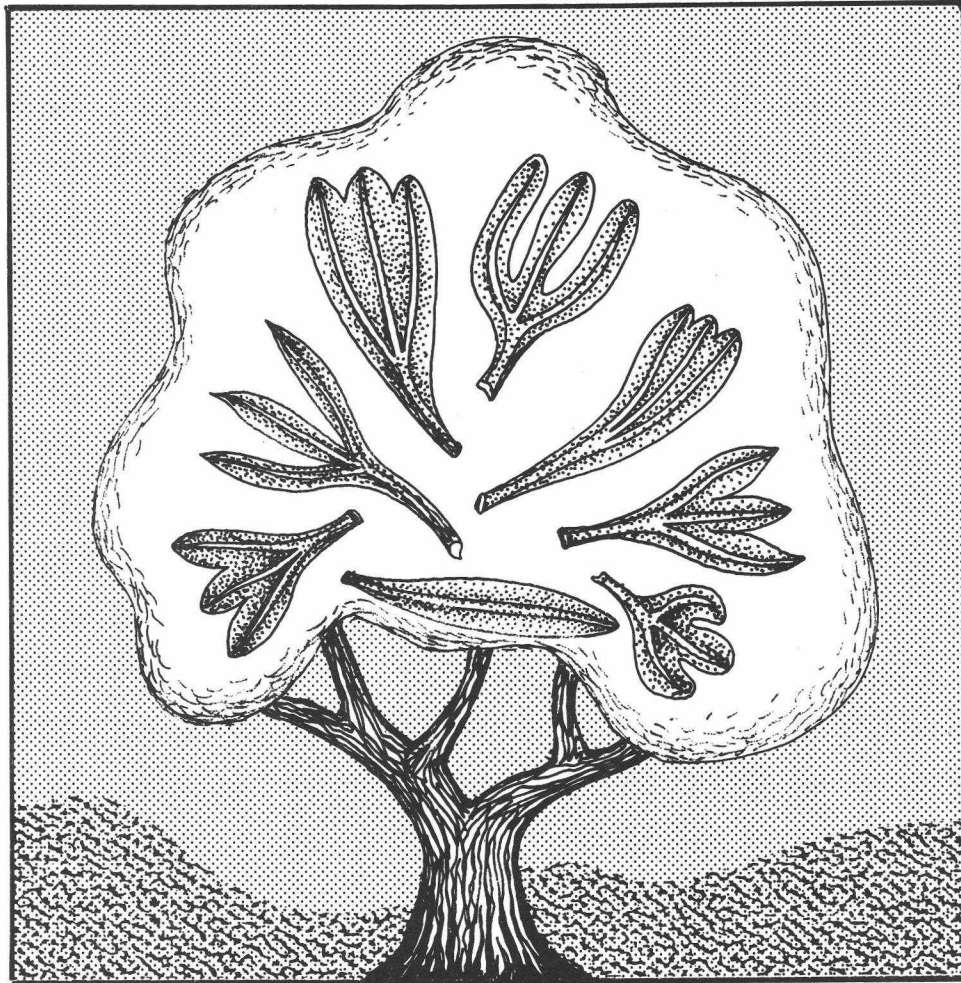
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# Taxonomy and Ecology of Sagebrush in Oregon



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# Taxonomy and Ecology of Sagebrush in Oregon

A. H. Winward

## ABSTRACT

Twelve important sagebrush taxa form an important component of the vegetation on at least 19 million acres in Oregon. Each kind of sagebrush has its own morphology, genetic make-up, and ecological requirements. Those acquainted with these 12 taxa find them useful in recognizing range sites and understanding site potential. This bulletin provides an update on information used to identify these 12 taxa. A general description of their geographic distribution is included, along with important features about their ecology and value as cover or forage.

## INTRODUCTION

The genus *Artemisia* (sagebrush) is known on most continents of the world. In the United States it occupies at least 96 million acres (Tisdale et al., 1969) and is found primarily in the steppe areas of the 11 western states.

In the Pacific Northwest and Intermountain regions there are 20-plus recognized species, subspecies, and forms of woody sagebrush, plus at least 15 herbaceous species. This paper covers only the woody taxa which have perfect flowers (Tribe Anthemideae). Twelve representatives from this tribe are common in Oregon (Table 1). These 12 taxa form an important component of the vegetation on at least 19 million acres in Oregon.

A considerable amount of controversy about the value of sagebrush exists. Questions continu-

ally arise as to where or how much sagebrush is needed for food or cover for native animals and birds. Should it be controlled or reduced, thereby releasing associated grasses and forbs for livestock and wildlife feed? If so, how should it be reduced—with chemicals, by fire, or mechanically? What was the ecological status of sagebrush during the presettlement period and how has this changed? What factors are responsible for this change?

While arguments continue, scientists are gathering facts about sagebrush that will help answer these questions.

For several years, scientists have been refining sagebrush taxonomy. What was once described as a few separate species have been found to be complexes of many subtaxa, each with its own morphology, genetic make-up, and ecological requirements. Those acquainted with the new classification system find it easier to understand the ecology of each taxon and can better predict responses to particular land management practices.

The objectives of this paper are to:

1. Provide an update of the kinds of sagebrush in Oregon.
2. Provide information necessary to recognize each important taxon in Oregon.
3. Stress the importance of keeping up with the new sagebrush classification system.

Table 1. Important woody *Artemisia* taxa in Oregon<sup>1</sup>

Scientific name	Common name	Standard abbreviation
<i>Artemisia rigida</i>	Scabland or stiff sagebrush	Arri
<i>Artemisia nova</i>	Black sagebrush	Arno2
<i>Artemisia arbuscula</i> ssp. <i>arbuscula</i>	Low sagebrush	Arara
<i>Artemisia arbuscula</i> ssp. <i>thermopola</i>	Cleftleaf sagebrush	Arart
<i>Artemisia longiloba</i>	Early sagebrush	Arlo2
<i>Artemisia tripartita</i> ssp. <i>tripartita</i>	Three-tip sagebrush	Artrt2
<i>Artemisia cana</i> ssp. <i>bolanderi</i>	Bolander silver sagebrush	Arcab
<i>Artemisia cana</i> ssp. <i>viscidula</i>	Mountain silver sagebrush	Arcav
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i>	Wyoming big sagebrush	Artrw
<i>Artemisia tridentata</i> ssp. <i>tridentata</i>	Basin big sagebrush	Artrt
<i>Artemisia tridentata</i> ssp. <i>vaseyana</i>	Mountain big sagebrush	Artrv
<i>Artemisia tridentata</i> form <i>spiciformis</i>	Subalpine big sagebrush	Artrs

<sup>1</sup> Common names and standard abbreviations from Garrison et al., 1976.

4. Discuss the status of land management practices based on the new system.

## TAXONOMY

Major morphological characteristics used to classify sagebrush include: leaf shape, size, and color; shrub height and general form; branching of the inflorescence and number of seeds per flower head (see key).

Since we deal with species, subspecies, and forms, some characteristics are somewhat subtle. For this reason, several features often are used to substantiate some separations. A few individual plants in most stands of sagebrush have unusual or uncommon features. Generally, these are caused by crossing of two taxa, "unnatural" environmental influences, or some other phenomenon that alters a plant's natural appearance. In field work, however, problems from unusual individuals are minimal since we are dealing with full populations, i.e., we are generally attempting to identify sagebrush in an area versus an individual plant.

In addition to using morphological features for classification, the number of chromosomes and chemical make-up have been used to identify genetic variations of sagebrush. A useful chemical method to separate some sagebrush taxa is to place a few grams of leaf material in a clear glass bottle, add enough methanol or ethanol to thoroughly saturate the leaves, and allow the material to react for one-half hour (Winward and Tisdale, 1969). The color of the fluorescing liquid can be

Table 2. Fluorescent color of the sagebrush-methanol solution under long-wave, ultraviolet light (by taxon)

Group I. Fluoresce shades of creamish-blue

*Artemisia arbuscula* ssp. *arbuscula*  
*Artemisia arbuscula* ssp. *thermopola*  
*Artemisia longiloba*  
*Artemisia tripartita* ssp. *tripartita*  
*Artemisia cana* ssp. *bolanderi*  
*Artemisia cana* ssp. *viscidula*  
*Artemisia tridentata* ssp. *vaseyana*  
*Artemisia tridentata* form *spiciformis*

Group II. Fluoresce shades of brownish-red

*Artemisia tridentata* ssp. *wyomingensis*  
*Artemisia tridentata* ssp. *tridentata*  
*Artemisia nova*  
*Artemisia rigida*

observed by shining a long-wave, ultraviolet light on the bottle in a darkened room. The solution will be shades of either creamish-blue or brownish-red. Colors which the sagebrush taxa fluoresce are listed in Table 2.

## ECOLOGY

Ecological features which influence where the sagebrush taxa grow include:

1. Elevation (as it affects temperature and soil moisture);
2. Soil depth, structure, drainage, and chemistry;
3. Total yearly moisture and seasonal distribution; and
4. Other less defined features such as number of cloud-free days per year and competing vegetation.

The following information is a general description of the geographic distribution and ecology of sagebrush in Oregon. Specific areas where some taxa have isolated or scattered occurrences may not be mentioned.

### *Artemisia rigida* (scabland sagebrush)

Scabland sagebrush occurs primarily in the north and northeastern part of the state. It is found as far west as Wasco County, as far south as northern Harney County, and north and east into Washington and Idaho. It grows on rocky, shallow soil areas from about 3,000 to 7,000 feet elevation. The grass species most commonly associated with scabland sagebrush under good conditions is Sandberg's bluegrass (*Poa sandbergii*). Biscuitroots (*Lomatium* species) also are common associates. Cheatgrass (*Bromus tectorum*) and other annual grasses and forbs become major increasers on disturbed sites of scabland sagebrush.

### *Artemisia nova* (black sagebrush)

Black sagebrush has been found in only three southeastern Oregon counties—Lake, Harney, and Malheur. It extends in small patches as far northwest as Christmas Valley but is more common in the southern part of these three counties. It appears to have some affinity to calcareous soils with a high amount of surface rock or pavement. It generally occurs above 4,000 feet elevation and in some states has been found as high as 8,000 feet. Several older range surveys describing black sagebrush in other areas of Oregon apparently are in error.

Vegetation commonly associated with this species under good conditions includes bluebunch wheatgrass (*Agropyron spicatum*), Indian ricegrass (*Oryzopsis hymenoides*), and, occasionally, needle-andthread grass (*Stipa comata*). Squirreltail (*Sitanion hystrix*) and Sandberg's bluegrass are common increasers. Under severely depleted conditions, a large amount of bare ground becomes exposed on black sagebrush sites.

***Artemisia arbuscula* subsp. *arbuscula* (low sagebrush)**

Low sagebrush is found in many parts of eastern Oregon. It occurs in nearly all counties east of the Cascades except the northern half of counties that border the Columbia River. It is found from less than 3,000 feet elevation to above 9,000 feet. With few exceptions, low sagebrush is found on areas with an impermeable "B" horizon or with shallow, unfractured bedrock. It withstands prolonged spring flooding and extensive summer drought.

Commonly associated species include bluebunch wheatgrass, Idaho fescue (*Festuca idahoensis*), and Thurber's needlegrass (*Stipa thurberiana*). Sandberg's bluegrass, a common increaser on low sagebrush sites, is followed by annual forbs and grasses as disturbances become more severe.

A variant of this taxon which occurs across central Oregon appears to have some tie to pumiceous soil. It is similar to other low sagebrush except it grows to 3 feet in height and can occur on deeper soils. Other morphological and ecological characteristics are similar to low sagebrush. More research is needed on this variant and on low sagebrush in general.

***Artemisia arbuscula* subsp. *thermopola* (clefthead sagebrush)**

Clefthead sagebrush is most common in Crook, Wheeler, Grant, and Baker counties. It occurs only at moderately high elevations (5,000 to 9,000 feet), usually in openings in lodgepole pine (*Pinus contorta*) or ponderosa pine (*Pinus ponderosa*) forests. It has the same associated species as low sagebrush and appears to have very similar ecological requirements except for its restriction to higher, cooler areas.

***Artemisia longiloba* (early sagebrush)**

Early sagebrush has been found in Deschutes, Crook, and northern Lake and Harney counties. It may be found in surrounding counties as more intensive search continues. Early sagebrush also has associated species and ecological characteristics similar to low sagebrush. Most likely it has unique environmental requirements which set it apart from low sagebrush, but these have not been identified. The early growth initiation and maturity dates warrant its treatment as a separate taxon. Aside from its earlier phenology, it may have been better described as a subspecies of *A. arbuscula*. It is found in several other states, primarily Idaho, Montana, and Wyoming, and the northern portions of Nevada, Utah, and Colorado.

***Artemisia tripartita* subsp. *tripartita* (three-tip sagebrush)**

In Oregon, three-tip sagebrush has been found only in Baker and northern Harney and Malheur counties. Several reports have recorded it in other areas of the state, but none, as yet, have checked out positive. Three-tip sagebrush can be found in all states that border Idaho, and it grows on moderate to deep, well-drained, loamy and sandy loam soils above 3,800 feet elevation. It resprouts profusely after fire or clipping and requires special management considerations.

Dominant grasses commonly associated with three-tip sagebrush include bluebunch wheatgrass, Idaho fescue, needleandthread grass, and Thurber's needlegrass. Under heavy disturbance, stands of three-tip sagebrush become dense brush fields with only a few understory species. Sandberg's bluegrass and Kentucky bluegrass (*Poa pratensis*) are common increasers in stands of this subspecies.

***Artemisia cana* subsp. *bolanderi* (Bolander silver sagebrush)**

Bolander silver sagebrush is found in internally drained basins scattered throughout the desert areas of the state. In Oregon it occurs as far northwest as Prineville, but its major acreage is in the southeastern one-third of the state. It has been found in western Idaho and in the northern portions of California and Nevada. It appears to have an upper limit of about 5,500 feet elevation, where it tends to grade into mountain silver sagebrush (described later). Soils in these basins are extremely clayey, are alkaline rather than saline, and generally have standing water for several weeks during winter and spring.

Currently, associated vegetation is sparse. No records exist to suggest that these areas ever supported much herbaceous vegetation. Alkali muhly (*Muhlenbergia richardsonis*) is generally found as a band around the margin of these basins. Wire rush (*Juncus*) also generally can be found scattered among the sagebrush plants. Some areas remain essentially barren between sagebrush plants, and this appears to be more a function of soil chemistry than of past abuse.

***Artemisia cana* subsp. *viscidula* (mountain silver sagebrush)**

As implied in the common name, mountain silver sagebrush occurs in the upper elevation, mountainous areas. It occurs from 5,500 feet elevation to above 8,000 feet and is most common in the east-central and southeastern corner of the

# Diagrammatic Key Showing Differentiating Characteristics which Separate Sagebrush Taxa in Oregon

	<b>A. rigida</b> (scabland sagebrush)																							
<b>A. nova</b> (black sagebrush)	 panicle entire lvs.	 spike cleft lvs.	<b>A. nova</b> (black sagebrush)																					
<b>A. arbuscula</b> ssp. arbuscula (low sagebrush)	 lobed lvs.	 cleft lvs.	 gray spike or raceme	 green, sticky panicle	<b>A. arbuscula</b> ssp. arbuscula (low sagebrush)																			
<b>A. arbuscula</b> ssp. thermopola (cleftleaf sagebrush)	 raceme entire lvs.	 spike cleft lvs.	 gray spike or raceme	 green, sticky panicle	 short cleft layering	 lobed non-layering	<b>A. arbuscula</b> ssp. thermopola (cleftleaf sagebrush)																	
<b>A. longiloba</b> (early sagebrush)	 lobed lvs.	 cleft lvs.	 gray spike or raceme	 green, sticky panicle	 seed set (July - mid Aug)	 seed set (mid Aug - Oct)	 wedged lvs non-layering	 cleft lvs layering	<b>A. longiloba</b> (early sagebrush)															
<b>A. tripartita</b> ssp. tripartita (three-tip sagebrush)	 panicle entire lvs.	 spike cleft lvs.	 cleft lvs.	 lobed, sticky	 cleft lvs.	 lobed lvs.	 cleft lvs. cleft, wedged spike or raceme	 cleft lvs.	 bellied lvs.	<b>A. tripartita</b> ssp. tripartita (three-tip sagebrush)														
<b>A. cana</b> ssp. bolanderi (Bolander silver sagebrush)	 entire lvs.	 cleft lvs.	 entire lvs.	 lobed lvs.	 entire lvs.	 lobed lvs.	 entire lvs.	 cleft lvs.	 entire lvs. belled lvs.	 entire lvs.	 cleft lvs.	<b>A. cana</b> ssp. bolanderi (Bolander silver sagebrush)												
<b>A. cana</b> ssp. viscidula (mountain silver sagebrush)	 entire lvs.	 cleft lvs.	 entire lvs.	 lobed lvs.	 entire lvs.	 lobed lvs.	 entire lvs.	 cleft lvs.	 entire lvs. belled lvs.	 entire lvs.	 cleft lvs.	<b>A. cana</b> ssp. viscidula (mountain silver sagebrush)	 silver-gray mt meadow & catchment stream edges basins											
<b>A. tridentata</b> ssp. wyomingensis (Wyoming big sagebrush)	 lobed lvs.	 cleft lvs.	 uneven top medium shb	 even top small shb	 uneven top medium shb	 even top small shb	 uneven top medium shb	 even top small shb	 uneven top medium shb	 even top small shb	 bellied lvs. uneven top	 cleft lvs. even top	 lobed lvs.	 entire lvs.	 lobed lvs.	 entire lvs.	<b>A. tridentata</b> ssp. wyomingensis (Wyoming big sagebrush)							
<b>A. tridentata</b> ssp. tridentata (basin big sagebrush)	 lobed lvs.	 cleft lvs.	 long, wedged uneven top large shb	 short, belled even top small shb	 long, wedged uneven top large shb	 short, belled even top small shb	 long, wedged uneven top large shb	 small, cleft even top small shb	 long, wedged uneven top large shb	 short, belled even top small shb	 long, wedge uneven top	 cleft lvs. even top	 wedged lvs. entire lvs.	 entire lvs.	 wedged lvs. entire lvs.	 tall shb. bellied lvs.	 medium shb. bellied lvs.	<b>A. tridentata</b> ssp. tridentata (basin big sagebrush)						
<b>A. tridentata</b> ssp. vaseyana (mountain big sagebrush)	 lobed lvs.	 cleft lvs.	 long, wedged uneven top large shb	 short, belled even top small shb	 long, wedged uneven top large shb	 short, belled even top small shb	 long, wedged uneven top large shb	 small, cleft even top small shb	 long, wedged uneven top large shb	 short, belled even top small shb	 long, wedge uneven top	 cleft lvs.	 wedged lvs. entire lvs.	 entire lvs.	 wedged lvs. entire lvs.	 even top wedged lvs.	 uneven top bellied lvs.	 even top widest lvs.	 uneven top widest lvs.	<b>A. tridentata</b> ssp. vaseyana (mountain big sagebrush)				
<b>A. tridentata</b> form spiciformis (subalpine big sagebrush)	 lobed lvs.	 cleft lvs.	 long, wedged uneven top large shb	 short, belled even top small shb	 long, wedged uneven top large shb	 short, belled even top small shb	 long, wedged uneven top large shb	 small, cleft even top small shb	 long, wedged uneven top large shb	 short, belled even top small shb	 long, wedge uneven top	 cleft lvs.	 wedged lvs. entire lvs.	 entire lvs.	 wedged lvs. entire lvs.	 even top wedged lvs.	 uneven top bellied lvs.	 even top layering	 uneven top non-layering	 >7 (flowers)	 4-6	<b>A. tridentata</b> form spiciformis (subalpine big sagebrush)	 layering	 non-layering

(Left characteristics refers to taxa on left)  
(Right characteristics refers to taxa at top)  
(Leaf sizes are not drawn to scale)

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KEY TO *ARTEMISIA* (SECTION TRIDENTATAE) IN OREGON

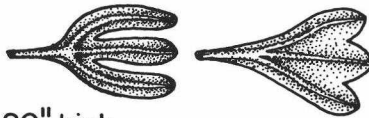
1a Leaves entire<sup>1/</sup>



2a Leaves silver-gray, plants from internally drained basins with seasonal flooding----- *A. cana* ssp. *bolanderi*

2b Leaves green-gray, plants along stream bottoms or meadow margins from mid to high elevations--- *A. cana* ssp. *viscidula*

1b Leaves divided or lobed



3a Mature<sup>2/</sup> shrubs less than 20" high

4a Leaves divided (lobe length > 3 times width)



5a Flower stalk leaves divided, inflorescence spicate, all leaves winter deciduous-----



----- *A. rigida*

5b Flower stalk leaves entire



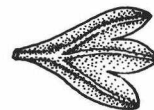
6a Inflorescence paniculate, upper flower stalk leaves much longer than flower heads---

----- *A. tripartita* ssp. *tripartita*

6b Inflorescence spicate or racemose, flower stalk leaves equal or only slightly longer than flower head-----

----- *A. arbuscula* ssp. *thermopola*

4b Leaves lobed (lobed length < 3 times width)



7a Inflorescence paniculate, seed stalks brownish and persist into following year-----



----- *A. nova*

<sup>1/</sup> Key based on persistent (overwintering) leaves unless otherwise noted.

<sup>2/</sup> Mature infers at least 20 years old (see xylem layers).



KEY TO ARTEMISIA (CONTINUED)

7b Inflorescence spicate or racemose,  
seed stalks grayish and weakly persistent



8a Seeds mature mid-July to mid-August----- *A. longiloba*

8b Seeds mature late August to October-- *A. arbuscula ssp. arbuscula*

3b Mature shrubs taller than 20"

9a Uneven topped shrubs, flower stalks  
arise throughout crown



10a Mature plants > 40" in height,  
leaf margins straight----- *A. tridentata ssp. tridentata*



10b Mature plants < 40" in height,  
leaf margins belled outward--- *A. tridentata ssp. wyomingensis*

9b Even topped shrubs, flower stalks arise from  
upper crown and extend above foliage



11a Leaf margins belled outward,  
inflorescence spicate or racemose-- *A. arbuscula ssp. arbuscula*



11b Leaf margins straight, inflorescence  
paniculate



12a Four to six flowers per head--- *A. tridentata ssp. vaseyana*



12b More than six flowers per head,  
plant often layering----- *A. tridentata form spiciformis*





state. As with Bolander silver sagebrush, mountain silver sagebrush grows in areas that have high seasonal water tables. Sites supporting this subspecies are not internally drained, however, and include streamsides and meadow margins. It has been found in all states west of the Continental Divide.

Communities of mountain silver sagebrush are rich floristically and may produce as many as 2,000 pounds per acre (dry weight) of herbaceous vegetation. Numerous rushes and sedges (*Carex* spp.) occur on these sites along with native grasses such as slender wheatgrass (*Agropyron caninum*), Nevada bluegrass (*Poa nevadensis*), and several brome and fescue grasses. Many of the seeded grasses such as timothy (*Phleum pratense*), orchardgrass (*Dactylis glomerata*), and mountain brome (*Bromus carinatus*) are now present on these sites. In areas where these grass species have not become established, the understory is composed of a dense stand of Kentucky bluegrass and rushes and sedges. Only under severe disturbances do these areas have low ground cover.

#### *Artemisia tridentata* subsp. *wyomingensis* (Wyoming big sagebrush)

Wyoming big sagebrush is the most xeric member of the big sagebrush group. It is the most common sagebrush on the Oregon High Desert and is found on moderately deep, well-drained soils. In many portions of the state, the soils are slightly calcareous to the surface. In Oregon, its northern limits are near Madras in central Oregon and Baker in eastern Oregon. It is not common above 6,000 feet elevation. Where it does occur in the mountainous areas of the state, it is restricted to the more xeric environments.

Associated grasses include bluebunch wheatgrass, needleandthread grass, Thurber's needlegrass, and, occasionally, Idaho fescue. Squirrel-tail is a common increaser on many Wyoming big sagebrush sites, except on soils especially droughty or slightly saline where this grass is a natural dominant. Cheatgrass and Sandberg's bluegrass are common increasers. Depending on the stage of disturbance, Wyoming big sagebrush sites may support combinations of these grasses and annual forbs or a considerable amount of bare ground. It must be noted, however, that even under natural conditions, Wyoming big sagebrush sites may have about 25 percent bare ground under the most restrictive environments. Other sites would be expected to have less bare ground as limiting factors become less severe. The most mesic Wyoming big sagebrush sites would have only about 5 or 10 percent bare ground under natural conditions.

It is possible that cryptograms fill a major portion of these otherwise bare spaces with no disturbance, but the degree of this is unknown. Relatively few perennial forbs occur with this subspecies, even under undisturbed conditions.

#### *Artemisia tridentata* subsp. *tridentata* (basin big sagebrush)

Basin big sagebrush is found in scattered, relatively small stands in every county of Oregon east of the Cascade Mountains. On an acreage basis, however, it represents a minor portion of the sagebrush region in the state. Areas where basin big sagebrush once was more extensive are now under cultivation. It grows on deep, well-drained soils and, depending on percent slope, is a good indicator of arable land. It is found from 100 feet elevation along the Columbia River to above 7,000 feet in most mountain ranges. Above 6,000 feet elevation, it is generally restricted to dry, shallow soil sites with southerly aspects or around the perimeter of tallus patches.

Grasses that occur with this subspecies are similar to the ones that grow with Wyoming big sagebrush. Additionally, basin wildrye (*Elymus cinereus*) may occur on bottomlands with slightly saline soils or on soils with a source of groundwater within a few feet of the surface. Perennial forbs are more abundant than on Wyoming big sagebrush sites and potential herbaceous production is from one-third to two times higher. Squirrel-tail and Sandberg's bluegrass are increasers on disturbed sites, with annual forbs and grasses becoming more abundant as perennial vegetation is reduced.

#### *Artemisia tridentata* subsp. *vaseyana* (mountain big sagebrush)

Mountain big sagebrush is found throughout the upper foothill and mountain areas of the state at elevations ranging from 3,500 to 9,000 feet. It also is found in all counties east of the Cascade Mountains. It grows on deep, well-drained soils where moisture is available most of the summer and is common in all Intermountain and Pacific Northwest states.

Many species of forbs, grasses, and other shrubs are often found growing with it. It is not uncommon to find 40 plant species in a stand of this sagebrush. Dominant perennial grass species under natural conditions include bluebunch wheatgrass, Idaho fescue, needleandthread grass, Thurber's needlegrass, and junegrass (*Koeleria cristata*). Basin wildrye is a common associate in areas where moisture in the rooting zone is available through summer. Increasers include Ken-

tucky bluegrass and Sandberg's bluegrass, squirreltail, and annual bromes and fescues. Generally, disturbed areas support a few remnant perennial species intermixed with annuals and dense sagebrush.

An unnamed variant of mountain big sagebrush has been observed in central and northeastern Oregon. It occurs at the lower edge of the western juniper (*Juniperus occidentalis*) zone and extends into the steppe areas. It appears to have developed on pumiceous soil, but this has not been adequately researched. It was originally believed to be the "X" big sagebrush found in west-central Idaho, but chromatographic patterns do not confirm this. More needs to be known about this variant since areas in which it is found appear to be especially difficult to manage. Native and seeded grasses have been difficult to establish, and rabbitbrush (*Chrysothamnus* spp.) has become extremely dense in areas that have been opened up through disturbances.

### *Artemisia tridentata* form *spiciformis* (subalpine big sagebrush)

Subalpine big sagebrush is restricted to areas above 5,000 feet elevation and is more common from 6,500 to 8,000 feet. It is found in most eastern Oregon counties including those on the east slopes of the Cascade Mountains. It occurs as a discontinuous patch in the forest openings except on Steens Mountain, where it occupies the upper one-third of the mountain (above 7,000 feet). On more xeric sites at these elevations, mountain big sagebrush may occur as an inclusion within stands of subalpine big sagebrush.

Dominant native grasses include Idaho fescue and mountain brome, with occasional stands of elk sedge (*Carex geyeri*). Slender wheatgrass and bluebunch wheatgrass often occur but are subordinate to the fescue and brome. Increaser species include western needlegrass (*Stipa occidentalis*), oniongrasses (*Melica* spp.), bluegrasses (*Poa* spp.), and several sedges. Cheatgrass and Sandberg's bluegrass are seldom very competitive in these environments. Extremely dense stands of subalpine big sagebrush often support high populations of gophers (*Thomomys* spp.) in the winter. Their burrowing activities result in an increase in annual forb species.

## MANAGEMENT ALTERNATIVES

Each sagebrush taxon mentioned has unique ecological features that should be considered in its management. Since scabland sagebrush grows on extremely shallow, rocky soils, a control program to reduce this type of sagebrush probably

would not be beneficial. The most commonly associated grass species, Sandberg's bluegrass, is not able to make use of additional soil moisture that may result from removal of sagebrush. Reseeding of exotic grasses such as crested wheatgrass would not be economical because of the nature of the soils. Scabland sagebrush appears to be moderately palatable to livestock and wildlife, at least seasonally. It probably has low protein content in the winter season since it is deciduous. Programs geared to managing most scabland sagebrush areas should be designed to maintain an open stand of sagebrush with a scattered understory of native perennial forbs and grasses, primarily Sandberg's bluegrass.

Black sagebrush sites also have low potential for improvement through reseeding. Where Sandberg's bluegrass has replaced the native bunchgrasses, extremely long-term plant succession will be required to allow return of bunchgrasses. This may never be accomplished. Black sagebrush in Oregon was found to be extremely low in palatability to mule deer and only moderately palatable to domestic sheep (Sheehy and Winward, 1976), but observations suggest antelope use it extensively. The relatively few acres of black sagebrush in Oregon should most likely be managed to maintain a mixture of sagebrush, grasses, and forbs.

Low sagebrush, cleftleaf sagebrush, and early sagebrush appear to have similar management requirements. The sites on which they grow often are unsuited for improvement through cultivation. Generally these areas have remnant forbs and grasses and will improve through proper range management practices. Some areas have been successfully reseeded to crested wheatgrass through a no-till operation. If Sandberg's bluegrass is abundant on the site, this will not be possible. Only a few areas supporting these sagebrush taxa have soil deep enough to allow seeding, however. In certain parts of the state, consideration should be given to wildlife since they use these areas extensively. Sheehy and Winward (1976) found low sagebrush to be among the more preferred taxa for forage in their study.

Three-tip sagebrush is unique in that it is the only sagebrush in Oregon which grows on deep, well-drained soil and resprouts. The combination of use by native and domestic animals and reduction by fire has allowed these areas to become more dense. Periodic chemical or mechanical treatments may be the only way to keep densities of this type of brush at a low enough level to allow healthy stands of herbaceous species. In the long run, proper grazing or even non-use will not maintain stable densities of this subspecies. Periodic removal or thinning will be necessary. Good

stands of crested wheatgrass have been established on these sites in other states.

Bolander and mountain silver sagebrush are resprouting subspecies. Most sites on which Bolander silver sagebrush grows are not suited for seeding grasses. The high water levels in the spring and alkaline soils do not allow establishment of crested wheatgrass. In a few locations, the perimeter of these basins probably would grow tall wheatgrass (*Agropyron elongatum*), but acreage limitations make this impractical. Bolander silver sagebrush was found to be among the group of sagebrush most preferred by deer and domestic sheep (Sheehy and Winward, 1976). Stands of this subspecies are used each winter by mule deer in the Silver Lake area. Overall, Bolander silver sagebrush sites should be left unsprayed and untilled because the shrubs and the few understory plants found growing in them are difficult to replace with other species.

Mountain silver sagebrush sites also are better left unaltered by mechanical treatments. Occasionally some stands may have to be thinned with fire or chemicals since they can become rather dense because of resprouting and layering, characteristics of this taxon. Maintenance of a good herbaceous cover will slow the densing process. Relative palatability of mountain silver sagebrush is unknown, but limited browsing has been observed on the flower stalks in the early fall.

Many areas of Wyoming big sagebrush have lost their natural understory vegetation. Livestock and wildlife have been partially responsible for these changes, but increased density of sagebrush and other shrubs due to fire protection also has had a significant impact. Where most of the remnant perennials have been lost, some type of brush control will have to be implemented before either native or introduced herbaceous species can be established. The most common grass species seeded on Wyoming big sagebrush sites in Oregon is crested wheatgrass. Bitterbrush (*Purshia tridentata*) is not a natural component of these sites, and attempts to seed this browse species into these areas probably will not be successful. Wyoming big sagebrush was intermediate to low on the palatability scale in Oregon (Sheehy and Winward, 1976).

Basin big sagebrush sites have a potential to produce more herbaceous vegetation than Wyoming big sagebrush sites. Most areas which once supported this subspecies now are being farmed. The majority of the stands which remain have lost many of their native understory species. Basin big sagebrush shows only moderate increases in density with disturbance of associated vegetation, but may increase greatly in foliage cover from crown enlargement. Where the understory species have

been lost, introduced grasses such as crested wheatgrass or, on some sites, intermediate wheatgrass (*Agropyron intermedium*) can be established. Basin big sagebrush was not a preferred taxon by deer and sheep (Sheehy and Winward, 1976).

Mountain big sagebrush has more potential for increasing its cover than any other sagebrush species. In some locations, dense stands are used by wildlife, especially during their reproductive phase. Some of these areas should be maintained in a dense brush stage for this important purpose. Mountain big sagebrush was in the high preference group for mule deer and sheep in Oregon (Sheehy and Winward, 1976). The majority of the many acres covered by this subspecies will need periodic sagebrush control efforts. Many areas are from two to six times more dense than they were historically (Winward, 1970). Often there are adequate representatives of native understory species on mountain big sagebrush sites. If seeding is necessary, crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass (*Agropyron trichophorum*) have been the most successful in Oregon.

Subalpine big sagebrush has a capacity to form extremely dense stands also. Its layering characteristic allows it to spread and occupy all areas on a site. Spray-release programs have generally been successful since native understory species usually are still present. Where seeding is necessary, intermediate wheatgrass, mountain brome, or smooth brome (*Bromus inermis*) have been most successful. Little reseeding of subalpine big sagebrush sites is needed in Oregon, but periodic reduction of brush cover will be necessary in some areas. Important fawning sites such as parts of the Steens Mountain may need to be left in the dense sagebrush stage. The relative palatability of this sagebrush has not been studied.

Wyoming, basin, mountain, and subalpine big sagebrush make up the major sagebrush acreage in the state. They have evolved to fit different habitats within the sagebrush region and their recognition as distinct taxa is basic for the management of the sagebrush-grass ranges. Differences in requirements for management among the four taxa are related to the kind of sites each occupies, their reaction to depletion of understory vegetation, their use by wildlife and livestock, and their seasonal growth development (Winward and Tisdale, 1977).

Big sagebrush sites have received the highest amount of alterations through range improvement treatments. Since areas on which they grow have deep, well-drained soils, often they can be improved by spray-release or reseeding programs. Spray programs essentially have stopped on public

rangelands. In 1978, only 43,000 acres of sagebrush were sprayed in Oregon, and this was almost exclusively on private land. This represents one-fourth of one percent of the sagebrush acreage in the state. Overall, less than two million acres of sagebrush have been altered in Oregon through range improvement practices, and some of this represents second- and third-time treatments on the same acreage.

Cover of brush is often used as a measure of range condition. However, unless cover is related to the particular subspecies in an area, it may have little value. For example, Wyoming big sagebrush stands range from 8 percent sagebrush cover on good condition range to 23 percent on highly disturbed ranges (Winward, 1970). Mountain big sagebrush, on the other extreme, ranges from 14 percent cover on good condition range to 41 percent on poor condition rangeland.

There have been differences of opinion about the geographic distribution of sagebrush in Oregon today compared to that of the presettlement period. Tisdale et al. (1969) concluded that aside from some local movement of sagebrush into meadows where the water table has been lowered, "the geographic area currently dominated by woody species of sagebrush is essentially the same today as in presettlement times."

In north-central Oregon there is some evidence that sagebrush has expanded from the intermound areas, where it is believed natural, onto the adjacent mounds which once supported grassland vegetation (Winward and Youtie, 1976). Absence of fire appears to be the main factor responsible for this change.

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