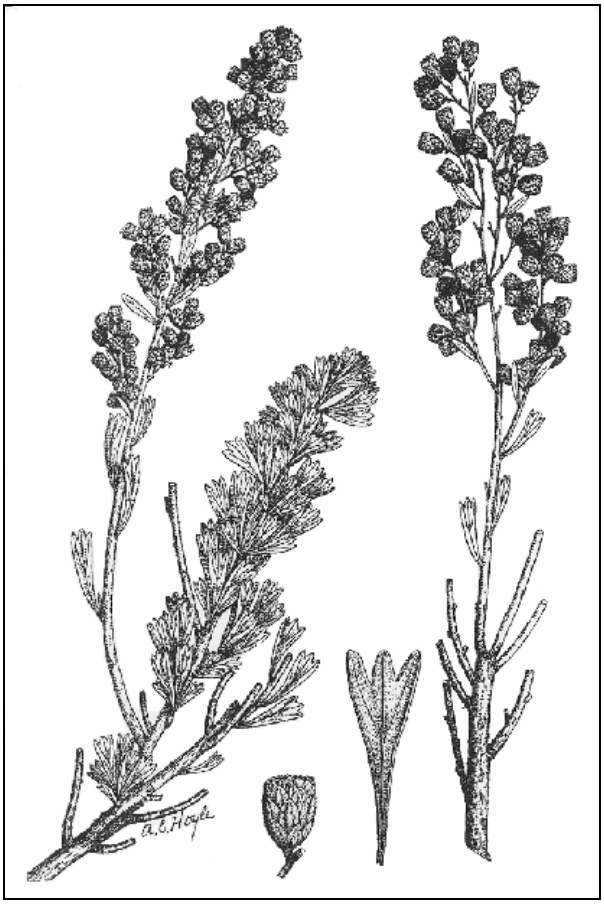
***Artemisia tridentata* Nutt.** big sagebrush
COMPOSITAE

Synonyms: *Artemisia tridentata* var. *angustifolia* Gray
Artemisia angusta Rydb.
Artemisia tridentata ssp. *typica* Hall & Clements



General Description.—Big sagebrush is an erect, aromatic, evergreen species, that lacks winter buds. It has numerous ecotypes that range in size from 0.4 to 4.5 m tall (Beetle 1960, Beetle and Young 1965, Diettert 1938, McArthur and others 1979). Growth forms are of two types; multistemmed and single trunks and are correlated with subspecific taxonomy. This species produces two types of branches, vegetative and flowering (Diettert 1938). The bark on older vegetative branches is stringy and black or dark brown in color. Bark on younger vegetative and inflorescences is heavily covered with trichomes that give the branches a silvery green to gray color. The leaves are also silvery green or gray. Principal leaves are narrowly cuneate or oblanceolate, 1.0 to 6.5 cm long and 2 mm to 2 cm wide, and usually are three-toothed at the apex (McArthur and others 1979). Leaf arrangement is spiral with a 2/5 divergence (Diettert 1938). Internodes are often so short that the leaves form dense, rosette-like clusters at the shoot tips (Diettert 1938). The haploid chromosome number of big sagebrush is nine (Diettert 1938, McArthur and Sanderson 1999). Two levels of ploidy have been reported among the three subspecies of big sagebrush–diploid (2n = 2x = 18) and tetraploid (2n = 4x = 36) (Diettert 1938, McArthur and Sanderson 1999). All three subspecies of big sagebrush contain polyploid populations (McArthur and Sanderson 1999).

Taxonomy.—There are three widely recognized subspecies of big sagebrush (Beetle 1960, Beetle and Young 1965). These are Wyoming big sagebrush (*A. t.* ssp. *wyomingensis*), basin big sagebrush (*A. t.* ssp. *tridentata*), and mountain big sagebrush (*A. t.* ssp. *vaseyana*). Subspecies can be separated on morphological, chemical, and ecological characteristics (McArthur and others 1979, Welch 2002). Wyoming big sagebrush occupies the drier sites that range from 20 to 32 cm of precipitation, 31 to 149 cm for mountain big sagebrush with basin big sagebrush somewhat between the other two subspecies (Welch 2002). Some authorities have divided mountain big sagebrush into three forms, varieties, or subspecies depending on the authority being quoted. One is called subalpine big sagebrush, *A. t.* ssp. *spiciformis*, (McArthur and Goodrich 1986) or *A. t.* ssp. *vaseyana* f. *spiciformis* (Beetle and Johnson 1982). The second is referred to as "X" big sagebrush, or xeric big sagebrush or *A. t.* ssp. *xericensis* (Welch 2002). Lastly, a variety of mountain big sagebrush is called *A. t.* ssp. *vaseyana* var. *pauciflora* (Welch 2002).

Range.—Beetle (1960) describes the range or distribution of big sagebrush in these terms: "occupying a great variety of sites at scattered localities in southern Montana and central to western Wyoming; southern-central British Columbia, south through central Washington, to the Columbia River; from the south side of the Blue Mountains in northeastern Oregon, throughout central and southeastern Oregon, southwestern and central Idaho to northern Utah, Nevada, and northwestern California; from the northern great basin areas of California,

Nevada, and Utah, extending southward at elevations from 5,000 to 7,000 feet and extending into western Colorado, northwestern New Mexico, northern Arizona; at much lower elevations in southern California and northern Lower California, Mexico." It also occupies areas of the northern Great Plains in the States of North and South Dakota, Montana, Wyoming, and Nebraska (Welch 2002).

Ecology.—Big sagebrush grows in a variety of soils throughout its range from arid plains, valleys, foothills, to mountain slopes, from 500 to 3,400 m elevation (McArthur and others 1979, Welch 2002). It has been found growing on five soil order: Alfisols, Aridisols, Entisols, Inceptisols, and Mollisols. It can be found growing on all 12 soil textural classes, but it is most often found on loams or sandy loams (Welch 2002). Chemical properties of big sagebrush soils are highly variable (pH 5.9 to 10.0 and organic carbon 0.62 to 4.14 percent) but two characteristics are common: they are well-drained and contained low concentrations of salts (Welch 2002). Depending on subspecies, as many as 40 plant species (grasses and forbs) can grow with big sagebrush (Welch 2002). Big sagebrush is not fire tolerant and can be killed by a number of pathogenic fungi, insects, and environmental conditions such as winter kill or winter induced drought (Welch 2002).

Reproduction.—The growth of inflorescence starts in late spring and is complete by late summer to early fall (Welch 2002). Flowering occurs during early to late fall with fruit development commencing almost simultaneously with flowering. Thus reproductive growth occurs when water supplies and temperatures are not particularly favorable; in fact, during this period big sagebrush plants have started shedding ephemeral leaves and neighboring plants species are largely dormant (Welch 2002). However, inflorescences do generate positive net photosynthesis at a time when whole plant is in a water conservation mode (Welch 2002). Big sagebrush achenes or seeds are small, weighing from 0.00018 to 0.00025 g (Welch 2002). Time of seed dispersal is highly variable among stands and somewhat dependent on elevation; some starting in mid-fall other not until early winter. Most seeds germinate immediately after snow melt or after late-winter or early spring storms (Welch 2002). The seeds possess no special adaptations for wind dispersal, but are wind dispersed to a maximum distance of 30 m from the mother plant. Hence seedlings placement is heavily depended on wind direction (Welch 2002). Big sagebrush forms a weak soil seed bank (Welch 2002). A single mature big sagebrush plant can produced upward of 500,000 seeds, although, excessive browsing can reduce inflorescences production by a factor of 20 (Welch 2002). The seeds must lie on the soil surface or be buried not more than 5 mm for successful emergence (Welch 2002).

Growth and Management.—Vegetative growth starts in early spring and declines when soil moisture becomes deficient. In general, Wyoming big sagebrush, the smallest of the subspecies, has the slowest vegetative growth rate and produces the least amount of biomass. Basin big sagebrush has the fastest growth rate and is the largest of the subspecies (McArthur and others 1979, Welch 2002). In the past 50 years or more, management has erroneously perceived big sagebrush to be a highly competitive, dominating, and suppressive species of grasses and forbs (Welch 2002). Thus a variety of techniques have been developed to kill big sagebrush (Welch 2002). As more studies show the importance of big sagebrush in maintaining it's ecosystem, techniques have been and continue to be developed to restore big sagebrush to its native sites (Welch 2002).

Benefits.—Big sagebrush is the keystone species of a large and highly variable ecosystem of Western United States (Welch 2002). It is literally a "nursing mother" to a host of organisms ranging from microscopic to large mammals and is what supports life in Bailey's (1896) description: "One never recovers from his surprise that there should be so much life where apparently there is so little to support it." Species that depend directly or indirectly on big sagebrush are many: 31 species of fungi, 52 species of aphids, 10 species of insects that feed on aphids, 42 species of midges and fruit flies that induce galls, 20 species of insects that parasitize the gall inducers, 6 species of insects that hibernate in big sagebrush galls, 18 species of beetles, 13 species of grasshoppers, 13 species of shield-back katydids, 16 species of thrips, 74 species of spiders, 24 species of lichens, 16 species of paintbrushes, 7 species of owl-clovers, 5 species of bird's beaks, 3 species of broom rapes, and a host of large and small mammals, birds, and reptiles (Welch 2002). Soil fertility is higher under big sagebrush canopy cover than outside the canopy (Welch 2002). Roots of other plants can tap into these islands of fertility (Krannitz and Caldwell 1995). Also, by a process known as "hydraulic lift or hydraulic redistribution" associated plants receive part of their needs from water pumped by big sagebrush to the soil surface from greater soil depths (Welch 2002). Lastly, big sagebrush provides a safe haven for grasses and forbs growing under its canopy from grazing domestic livestock (Welch 2002).

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