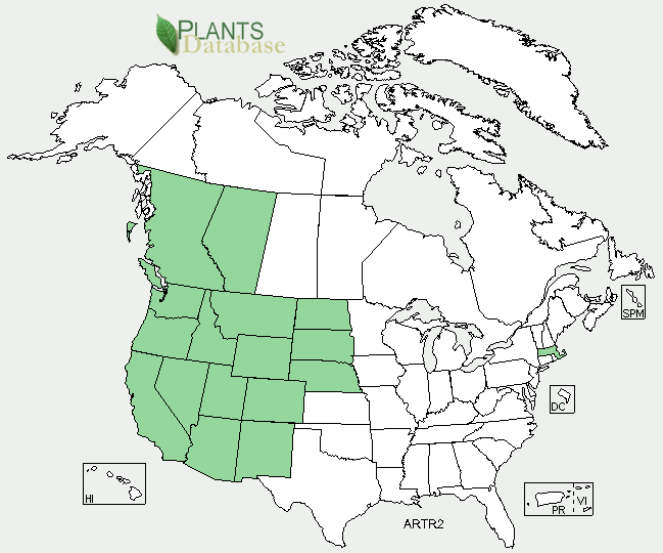
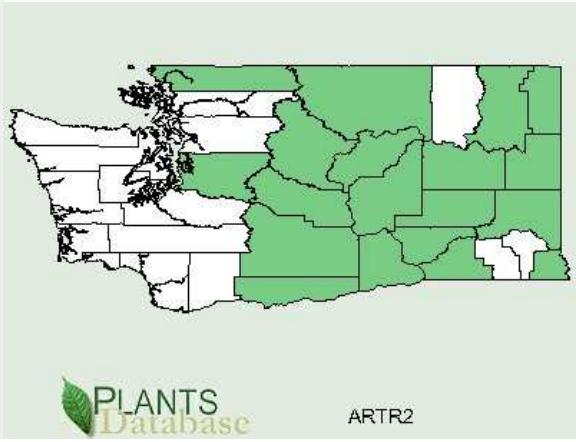
Plant Propagation Protocol for *Artemisia Tridentata*
ESRM 412 – Native Plant Production
Spring 2010

North America Distribution



Washington Distribution



TAXONOMY	
Family Names	
Family Scientific Name:	Asteraceae
Family Common Name:	Aster family
Scientific Names	
Genus:	Artemisia L.
Species:	Artemisia Tridentata
Species Authority:	Nutt.
Variety:	
Sub-species:	
Cultivar:	
Authority for Variety/Sub-species:	
Common Synonym(s)	Artemisia tridentata Nutt. ssp. parishii (A. Gray) H.M. Hall & Clem. Artemisia tridentata Nutt. ssp. spiciformis (Osterh.) Kartesz & Gandhi Artemisia tridentata Nutt. ssp. tridentata Artemisia tridentata Nutt. ssp. vaseyana (Rydb.) Beetle Artemisia tridentata Nutt. ssp. wyomingensis Beetle & Young Artemisia tridentata Nutt. ssp. xericensis Winward ex R. Rosentreter & R.

	Kelsey [1]
Common Name(s):	Big sagebrush; Big sage-brush; Big sage brush; Big sagebush; Big sage; Big western sagebrush; Big western sage; Big-leaf sagebrush; Bigleaf sagebrush; Tall western sagebrush; Tall western sage; Big mountain sagebrush; Common sagebrush; Common sage-brush; Common sage bush; Three-toothed sagebrush; Three-toothed sage-brush; Three-tooth sagebrush; Three-toothed sage; Three-tooth sage; Three tooth sage. [2]
Species Code	ARTR2
GENERAL INFORMATION	
Geographical range	See maps above for distribution in North America and Washington State.[1]
Ecological distribution:	Arid, desert and semi-desert conditions. It is the primary vegetation across vast areas of the Great Basin desert. ([4]) Some varieties can grow in areas up to 18 inches precipitation per year, but most occur in more xeric conditions.[3]
Climate and elevation range	Elevation ranges are variable: 4,800-5,800 feet (1463-1768 m) in Arizona, 100-7,000 feet (30-2134 m) in Oregon, 2,001-7,019 feet (610-2140 m) in northeastern Utah.[5, 3]
Local habitat and abundance; may include commonly associated species	Prefers deep, well drained soils. Dominates much of the dry interior of eastern Washington. Occurs with the following SAF cover types: 220 Rocky Mountain Juniper 237 Interior ponderosa pine [5] And the following Kuchler Plant associations: K022 Great Basin pine forest K023 Juniper-pinyon woodland K024 Juniper steppe woodland K037 Mountain mahogany-oak scrub K038 Great Basin sagebrush K039 Blackbrush K040 Saltbush-greasewood K041 Creosotebush K051 Wheatgrass-bluegrass K055 Sagebrush steppe K056 Wheatgrass-needlegrass shrubsteppe K057 Galleta-three-awn shrubsteppe K064 Grama-needlegrass-wheatgrass K066 Wheatgrass-needlegrass [5] Particularly in Washington, it dominates communities characterized by steppe vegetation. It commonly grows conjunction with: *Pinus ponderosa, Artemisia tripartita, Agropyron spicatum, Elymus cinereus, Stipa thurberiana, Purshia tridentata, Phlox longifolia, Balsamorhiza careyana,*

	Bromus tectorum, Pseudoroegneria spicata, Achnatherum thurberianum, Hesperostipa comata, Festuca idahoensis, and *Poa secunda*.[5]
Plant strategy type / succession stage	Every subspecies of Big sagebrush is well adapted for extracting moisture from all parts of the soil profile. This allows them to be highly competitive with surrounding grasses and forbs. Also an effective colonizer immediately following disturbance.[3,5]
Plant characteristics:	This shrub is nitrogen-fixing shrub that grows fairly slowly, usually living 40 to 50 years of age, some can exceed 100.[5,10] Plants are longer lived, more hardy and more aromatic when they are grown in a poor, dry soil. Established plants are very drought tolerant,[9] and susceptible to root rot if too wet. [10]
PROPAGATION DETAILS	
Ecotype	Idaho fescue grassland, Big Prairie, Glacier National Park, Flathead Co., MT[6]
Propagation Goal	Plants
Propagation Method	Seed
Product Type	Container (plug)
Stock Type:	172 ml containers
Time to Grow	10 months
Target Specifications:	Height: 6 to 10 true leaves, 6cm tall Caliper: 1.7mm Root System: Firm plug in 172ml container
Propagule Collection:	Seeds must be collected in October with careful timing, as soon as the seeds have fully ripened. The seeds will turn brown and become easy to pull from the established plant. Collection at the improper time results in non-viable seed. Seed must then be kept well ventilated and spread evenly to dry for 3 to 5 days before cleaning.[6] Seeds may germinate in fall and winter in the southern part of big sagebrush's range, but most seeds germinate in the spring, as early as April.
Propagule Processing/Propagule Characteristics:	Seed is short-lived unless stored at low moisture content ((6 to 8%) at temperatures less than 10 °C, in which case it can be stored for 5 years or longer.[3] There are roughly 5,500,000 seeds per kilogram.[6]
Pre-Planting Propagule Treatments:	Seed should be hand cleaned using screens. Dormancy classification is "Non deep physiological dormancy," and can be broken through a 2 week cold-moist stratification. Different subspecies germinate optimally at different temperatures, but all seem to germinate best when the seeds are exposed to slightly fluctuating temperatures, and sown on the surface (need light to germinate).[6]
Growing Area Preparation / Annual Practices	Seeds should be grown outdoors, and sowed directly on to a growing medium of milled sphagnum peat, perlite, and vermiculite with Osmocote controlled release fertilizer (13N:13P2O5:13K2O) and Micromax fertilizer

for Perennial Crops:	(12%S, 0.1%B,0.5%Cu,12%Fe, 2.5%Mn, 0.05%Mo, 1%Zn) at the rate of 1 gram of Osmocite and 0.20 gram of Micromax per 172 ml container.[6]
Establishment Phase:	Medium should be kept slightly moist during germination. Germinates will appear after 2 weeks of temperatures above 22°C in spring. After 3 weeks of germination, 2 to 4 true leaves should be evident. Watering should be done in the early morning so the seedlings can dry during the day.[6]
Length of Establishment Phase:	4 weeks.
Active Growth Phase:	Both roots and shoots will grow rapidly after germination. Plants can be fertilized with a 20-20-20 NPK liquid fertilizer solution at 100 ppm during the growing season. Plants will be fully root tight 12 weeks after germination, roughly 2.5 cm in height, and with 10 to 12 true leaves.[6]
Length of Active Growth Phase:	12 weeks
Hardening Phase:	Watering should be gradually reduced during September and October. In preparation for winter, the plants should be fertilized with 10-20-20 NPK liquid fertilizer at 200ppm one time.[6]
Length of Hardening Phase:	4 weeks
Harvesting, Storage and Shipping:	Plants should be harvested in September, and stored during the winter in an outdoor nursery, preferably insulated by foam and snow.
Length of Storage:	5 months
Guidelines for Outplanting / Performance on Typical Sites:	Do not plant *A. Tridentata* outside of an elevation range 500 feet up or 1000 feet down from the area the seed was originally collected. Also, be sure the target planting site is not more than 300 miles away from the original collection site, and within the native distribution. This will minimize the risk of planting maladapted stock, increasing the survival and reproductive success.[4] Also, avoid alkaline soils and opt for well drained soils with lots of light.[3]
Other Comments:	Commonly used in restoration projects in the western US. Elk, muledeer, antelope, sheep, rodents, squirrels, and grouse all utilize the plant as a food source.[6] The species name, tridentata, refers to the 3-toothed leaves.[11]
PROPAGATION DETAILS	
Ecotype	Utah
Propagation Goal	Rooted cuttings

Propagation Method	Vegetative
Product Type	Propagules (cuttings,)
Stock Type:	N/A
Time to Grow	N/A
Target Specifications:	N/A
Propagule Collection:	Hand clippers to take terminal and lateral twigs with intact terminal buds, cut from the base of the previous season's growth. Cuttings should range in length from 8 to 12 cm and be treated and planted within 36 hours.[8] Cuttings obtained during in winter show typically show greater rooting activity than those collected from actively growing plants. It is highly crucial to identify plant sources that will give inherent height rootability.[8]
Propagule Processing/Propagule Characteristics:	One protocol calls for a perlite/vermiculite growing media in a greenhouse.[7]
Pre-Planting Propagule Treatments:	Multiple protocols have called for use of rooting hormone, one naming specifically a synthetic auxin treatment, talc-based indolebutyric acid IBA mixture.[7,8] The basal portion of each cutting was inserted into a peat pellet previously expanded with water.[8]
Growing Area Preparation / Annual Practices for Perennial Crops:	Both protocols called for spray irrigation. Specific conditions suggested were a greenhouse temperature kept at 65-73ºF during the day and 55-59ºF at night. Suggested durations and intervals for spray irrigation were 10 seconds every 15 minutes for 12 hours of the day.[7] One protocol also employed uniform heating under the growing bed.
Establishment Phase:	This species has been noted to have very variable rootability attributed to genetic diversity. Each cutting will vary in its ability to root and the degree to which it does produce roots.[8]
Length of Establishment Phase:	Rooting phase will last from 40-52 days.[8]
Active Growth Phase:	Information not available
Length of Active Growth Phase:	Information not available
Hardening Phase:	Information not available
Length of Hardening Phase:	Information not available
Harvesting,	Information not available

Storage and Shipping:	
Length of Storage:	Information not available
Guidelines for Outplanting / Performance on Typical Sites:	Information not available
Other Comments:	One source mentions that current and previous research is not clear with regard to procedures for vegetative sagebrush propagation.[8]
	INFORMATION SOURCES
References:	1. "Artemisia Tridentata Nutt. Plants Profile." *USDA Plants Database*. Web. 20 Apr. 2010. <http://plants.usda.gov/java/profile?symbol=ARTR2>. 2. "UCJEPS: Jepson Interchange for California Floristics: Artemisia Tridentata Nutt." University of California, Berkley and Jepson Herbaria Portal to California Flora. Web. 20 Apr. 2010. <http://ucjeps.berkeley.edu/cgi-bin/get_cpn.pl?ARTR2>. 3. ESRM 412 Plant Protocol for *Artemisia tridentata*, Nutt by Anne Andreu, 4/21/03. <http://depts.washington.edu/propplnt/Plants/Artemisia%20tridentata%20data%20sheet.htm> 4. United States. USDA Forest Service. Rocky Mountain Research Station. Evolution and Taxonomy of Sagebrush. By E. Durant McArthur. Shrub Sciences Laboratory, Provo, Utah. Web. 20 Apr. 2010. <http://www.rangelands.org/pdf/esd_mcarthur.pdf>. 5. Tirmenstein, D. 1999. Artemisia tridentata spp. tridentata. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2010, April 19]. 6. Luna, Tara; Evans, Jeff.; Wick, Dale. 2008. Propagation protocol for production of container *Artemisia tridentata* Nutt. *vasseyena* (Rydb.) Beetle plants (172 ml containers); USDI NPS - Glacier National Park, West Glacier, Montana. In: Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 20 April 2010). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery. 7. Butler, Jennifer; Frieswyk, Christin. 2002. Propagation protocol for vegetative production of *Artemisia tridentata* seeds; USDI NPS - Rocky Mountain National Park, Estes Park, Colorado. In: Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 21 April 2010). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery. 8. Alvarez-Cordero, Eduardo, and C. M. McKell. "Stem Cutting Propagation of Big Sagebrush (Artemisia Tridentata Nutt.)." *Journal of Range Management* 32.2 (1979): 141-43. *JSTOR*. Web. 20 Apr. 2010. <http://www.jstor.org/stable/3897559>.

	9. “Artemisia Tridentata - Nutt. Sage Brush." *Plants For a Future- Edible, Medicinal and Useful Plants for a Healthier World*. 2008. Web. 20 Apr. 2010. <http://www.pfaf.org/database/plants.php?Artemisia+tridentata>. 10. Artemisia Tridentata Nutt." *Native Plant Database*. University of Texas at Austin, 2010. Web. 20 Apr. 2010. <http://www.wildflower.org/plants/result.php?id_plant=artr2>. 11. Faucon, Philippe. "Big Sagebrush." *Www.desert-tropicals.com*. 2005. Web. 20 Apr. 2010. <http://www.desert-tropicals.com/Plants/Asteraceae/Artemisia_tridentata.html>.
Other Sources Consulted:	12."Artemisia Tridentata Nutt." *Tropicos.org*. Missouri Botanical Garden, 2010. Web. 20 Apr. 2010.
Protocol Author:	Mario Abata
Date Protocol Created or Updated:	04/20/10

Note: This template was modified by J.D. Bakker from that available at: http://www.nativeplantnetwork.org/network/SampleBlankForm.asp

Original Protocol

Species (common name, Latin name):

Big Sagebrush, *Artemisia tridentata*, Nutt.

Range

Occurs from British Columbia to Baja California, east to the Dakotas and New Mexico. (Hitchcock and Cronquist 1973)

Climate, elevation

Occurs in semiarid climatic regimes in desert and semi-desert conditions. Basin big sagebrush (*A. t. ssp. tridentata*) grows on sites with deep, well-drained soils and average precipitation between 10-18 inches per year (occurring mainly in the fall and winter months). The other big sagebrush subspecies (*A. t. ssp. spiciformis, A. t. ssp. vaseyana, A. t. ssp. wyomingensis, A. t. ssp. xericensis*) tend to occur on more xeric sites.

Elevation ranges are variable: 4,800-5,800 feet (1463-1768 m) in Arizona, 100-7,000 feet (30-2134 m) in Oregon, 2,001-7,019 feet (610-2140 m) in northeastern Utah.

(FEIS database)

Local occurrence (where, how common)

Locally, sagebrush occurs as a dominant shrub in eastern Washington shrub-steppe and dry Ponderosa pine savannas. (Franklin and Dyrness 1973)

Habitat preferences

Prefers deep well-drained soils; locally occurs throughout the dry interior of eastern Washington; dominates the Columbia Basin shrub-steppe zone.

(Franklin and Dyrness 1973)

Plant strategy type/successional stage (stress-tolerator, competitor, weedy/colonizer, seral, late successional)

Prolific colonizer following disturbances; considered a topographic and edaphic climax dominant species over most of its range. (Franklin and Dyrness 1973, FEIS database)

Associated species

Common associates are *Pinus ponderosa, Artemisia tripartita, Agropyron spicatum, Festuca idahoensis, Elymus cinereus, Stipa thurberiana, Purshia tridentata, Phlox longifolia, Balsamorhiza careyana, Lithophragma bulbifera, Lomatium spp.* and *Microseris troximoides*. (Franklin and Dyrness 1973)

May be collected as: (seed, layered, divisions, etc.)

May be propagated by seed in the spring and by cuttings taken in late summer through winter.

Collection restrictions or guidelines

Seed production occurs from October to December and most seed is shed in the fall, although some may remain on the plant through the winter. Seeds may germinate in fall and winter in the southern part of big sagebrush's range; however, most seeds germinate in the spring as early as April. (FEIS database)
Sagebrush seeds are collected by beating or stripping them into shoulder hoppers, baskets, or bags. (Woody Plant Seed Manual)

Seed germination (needs dormancy breaking?)

Dormancy depends on ecotype of collected seeds; individuals from southwestern locations tend to be germinable immediately while northern individuals tend to have a cold stratification or light requirement for germination. Dormancy can be broken by a short (2-week) period of moist, cold stratification and, in many cases, through after-ripening that occurs during storage. (Woody Plant Seed Manual)

Seed life (can be stored, short shelf-life, long shelf-life)

Big sagebrush seeds have been determined to be relatively short-lived, remaining viable less than 5 years in warehouse storage. Storing with a low moisture content (6 to 8% is optimal) and at relatively low temperatures (<10 °C) can extend storage life to 5 years and possibly longer. (Woody Plant Seed Manual) Most sagebrush seeds are not viable in the seedbank for more than 1 year. Fire may reduce emergence of big sagebrush (FEIS database).

Recommended seed storage conditions

Storing with a low moisture content (6 to 8% is optimal) and at relatively low temperatures (<10 °C) can extend storage life to 5 years and possibly longer. (Woody Plant Seed Manual)

Propagation recommendations (plant seeds, vegetative parts, cuttings, etc.)

May be direct seeded, grown as bareroot or containerized material, or propagated by cuttings. Transplants of wild seedlings are also successful. (Woody Plant Seed Manual)
Cuttings should be taken in fall or winter, dipped in rooting hormone and placed in sandy substrate or peat pellets and exposed to bottom heat and top misting. (Alvarez-Cordoza and McKell 1979)

Soil or medium requirements (inoculum necessary?)

Grow best in light, well-drained soils. Prefer not to be in alkaline soils.

Installation form (form, potential for successful outcomes, cost)

Easily established by direct seeding in late fall or onto snow in winter or by transplanting wild seedlings in the spring. May also be installed in the spring as containerized or bareroot nursery grown material. Containerized material requires careful hardening before transplantation. (Woody Plant Seed Manual)

Recommended planting density

3' centers.

For direct seeding Meyer recommends a seeding “rate of 0.1 to 0.2 kg/ha (1.5 to 3 oz/ac) on a pure live seed (PLS) basis for a lot that averages 4 million seeds/kg (113,400/oz)” (Woody Plant Seed Manual).

Care requirements after installed (water weekly, water once etc.)

Moisture is often the limiting factor in establishing sagebrush from seeds; therefore, watering through the first summer will help ensure the success of direct seeding. (Woody Plant Seed Manual)

Normal rate of growth or spread; lifespan

Sagebrush grows fairly quickly (especially *A. t. ssp. tridentata*) and is reproductively mature by age 2 years. (FEIS database)

Sources cited

Alvarez-Cordero, E. and C. M. McKell. 1979. Stem cutting propagation of big sagebrush: *Artemisia tridentata*. Journal of Range Management 32 (2).

FEIS database: Accessed on 4/20/03, http://www.fs.fed.us/database/feis/plants/shrub/arttrit/index.html

Franklin, J. F. and C. T. Dyrness. 1973. Natural Vegetation of Oregon and Washington. Oregon State University Press, Corvallis.

Hitchcock, C. L, and A. Cronquist. 1973. Flora of the Pacific Northwest, An Illustrated Manual. University of Washington Press, Seattle.

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Data compiled by (student name and date): Anne Andreu, 4/21/03