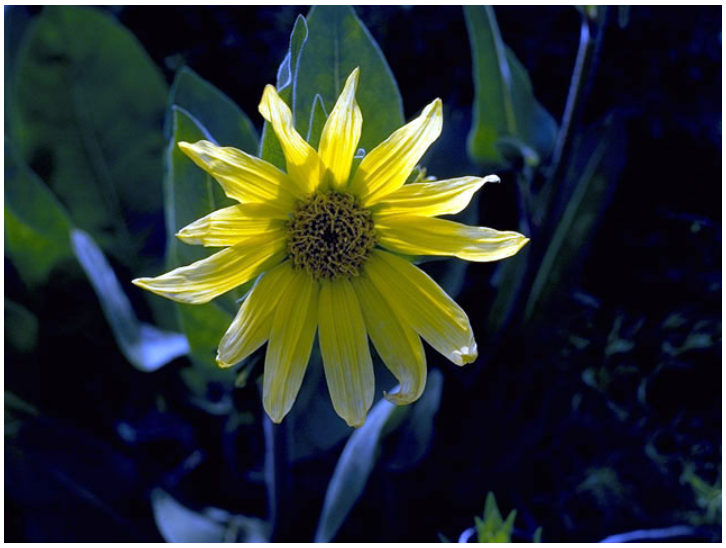
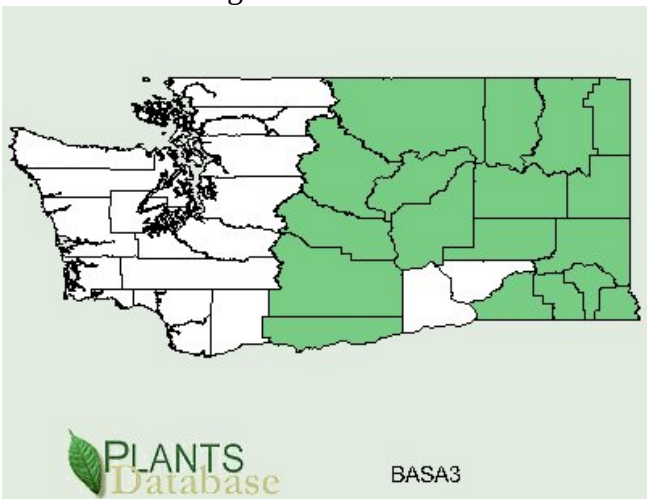
Plant Propagation Protocol for *Balsamorhiza sagittata*
ESRM 412 – Native Plant Production
Spring 2011



Source: Lady Bird Johnson Wildflower Center

North American Distribution

Washington State Distribution



Source: USDA PLANTS Database

TAXONOMY	
Family Names	
Family Scientific Name:	Asteraceae
Family Common Name:	Sunflower family
Scientific Names	
Genus:	Balsamorhiza

Species:	*sagittata*
Species Authority:	(Pursh) Nutt.
Variety:	
Sub-species:	
Cultivar:	
Authority for Variety/Sub-species:	
Common Synonyms:	No common synonyms.
Common Names:	Arrowleaf Balsamroot, Balsamroot, Breadroot, Graydock
Species Code:	BASA3
GENERAL INFORMATION	
Geographical range:	Western US east to the Dakotas and south to Colorado and Arizona. See Distribution Maps above.
Ecological distribution:	Dry, open prairies and meadows and open Ponderosa pine woodlands.[4] Precipitation in the Intermountain Range is adequate between 9 and 13 inches.[3]
Climate and elevation range:	Arrowleaf Balsamroot has been found to naturally occur between 1,000 to 9,000 feet [6], and 4000-8000 ft.[2]
Local habitat and abundance:	Arrowleaf Balsamroot is well adapted to plains, valleys, foothills, and low mountain ranges. It occurs on open slopes and ridges throughout the sagebrush (*Artemisia spp.*), oak (*Quercus spp.*) brush, ponderosa pine (*Pinus ponderosa*), and higher habitat types. It is found on well-drained soils in open, fairly dry, sandy loam soils, and thrives on open south-facing slopes.[7]
Plant strategy type / successional stage:	Arrowleaf Balsamroot is listed as climax vegetation in interior ponderosa pine (*Pinus ponderosa var. scopulorum*) communities.[3] It is more commonly listed as a Mid-Serial plant in most of its native ecosystems, and a second-colonizer after fire disturbance.[3]
Plant characteristics:	*Balsamorhiza sagittata* is a cool-season, large, long-lived, perennial forb that grows 12 to 24 inches in height.[4] Fruit is a 4-angled, thickened, smooth, hairless achene.[4] Taproot reaches a diameter of 4 inches and a depth of 8.8 feet.[5] Basal leaves are cordate to sagittate in outline with entire margins and wooly pubescence. They arise from a branched, underground caudex to form dense rosettes.[4] Flowerheads are sunflower-like with “strap-shaped”

	ray flowers 1 to 2 inches long, and tubular disc flowers. Flowers are mostly solitary on long peduncles with mostly lanceolate cauline leaves which are much smaller than the basal leaves.[4]
PROPAGATION DETAILS	
Ecotype:	Pullman Area[4] USFS land, junction of Forest roads 68 and 85, Sevier County, Utah: 9030 ft. elevation.[9] USFS, Watson Ridge, Umpqua National Forest, Diamond Lake Ranger District, Oregon: 3400 ft. elevation.[9]
Propagation Goal:	Plants
Propagation Method:	Seed
Product Type:	Container (Plug)
Stock Type:	
Time to Grow:	5 Months.[4]
Target Specifications:	*Balsamorhiza sagittata* is a taprooted species, and therefore should be outplanted prior to the root plug becoming tight.[4]
Propagule Collection:	Seeds do not persist in the soil seedbank, and therefore need to be collected via flower head.[3] Seed is collected when the inflorescence is dry and the achenes are dark brown to black. The average fruit ripening date, west of the Continental Divide, is 14th of June.[3] "Shattering" is usually not a problem, however the seeds are easily subject to bird, animal and insect predation.[3] Store seed in paper bags at room temperature until cleaning.[4]
Propagule Processing/Propagule Characteristics:	Crush and rub flower heads, then run over a hand screen to separate the seeds. Remove fine material, unfilled and damaged seeds with an air column separator.[7] Store seed in controlled conditions at 40 degrees Fahrenheit and 40% relative humidity.[2] According to the study by Stevens et al, Seeds can be stored for up to 10 years and still be viable.[3]

	Seeds are relatively large, with a seed density of 1,850 to 3,000 per ounce (65-105/gram), or about 58,000 seeds per pound (127,600/kg).[3] The USDA Plants database states the average seed density is ~ 55,000 seeds/lb.[7]
Pre-Planting Propagule Treatments:	*Balsamorhiza sagittata* requires extended cold / moist stratification, with cool growing temperatures. Greenhouse temperatures can be lethal.[4] In a study by Young and Evans, Germination without stratification was very low and erratic. A 12-week period of stratification was required for maximum germination at 41 degrees Fahrenheit (5o C).[8] The 3-month stratification requirement of Arrowleaf Balsamroot is considered long for many "rangeland" seedbeds. In nature, Arrowleaf Balsamroot seeds need constant "snow-litter-soil interface", with continuous snow cover for at least 3 months. It is speculated that this may explain the occurrence of dense communities of *Balsamorhiza sagittata* on north-facing slopes where snowdrifts accumulate.[8]
Growing Area Preparation / Annual Practices for Perennial Crops:	In late November / early December, sow seeds in 10 cu. in. "Ray Leach Super Cell Conetainers" filled with Sunshine #4.[4] Cover seeds lightly with Sunshine #4 medium, then add a thin layer of pea gravel to prevent seed from floating when watered.[4] Water "Conetainers" deeply, then place outside for the winter. Water only during extended warm, dry spells.[4]
Establishment Phase:	Germination begins in March, as daytime temperatures increase. [4]
Length of Establishment Phase:	Germination and establishment occurs over a period of 3 weeks or more.[4]
Active Growth Phase:	Leave plants outside, so as to acclimate them to natural cool spring temperatures. Apparent growth of the seedlings is slow, but the taproots grow more rapidly.[4]
Length of Active Growth Phase:	1-2 months
Hardening Phase:	Since the plants are grown outside, additional hardening is not necessary.[4]
Length of Hardening Phase:	N/A
Harvesting, Storage and Shipping:	Information Not Available
Length of Storage:	Information Not Available

Guidelines for Outplanting / Performance on Typical Sites:	Transplant using an electric drill and portable generator, drilling 1.5 inch holes at the planting site. Handle plants gently to keep the taproot intact during transplanting.[4] Survival after 2 years in plantings, where competing vegetation is absent, averages ~ 65-70%.[4] New plants are slow to mature, and require 3 to 4 years to flower on the best sites, and 7 to 8 years on lower precipitation sites.[3]
Other Comments:	*Balsamorhiza sagittata* is a long-lived species with a massive taproot (up to eight feet deep). It is very difficult to move established plants.[4] There is no reported evidence that *Balsamorhiza sagittata* maintains a persistent seedbank.[8] *Balsamorhiza sagittata* is "topkilled" during fire disturbances, and subsequently regenerates from its caudex.[3] In the classification done by The Fire Management Plan for Craters of the Moon National Monument in Idaho, *Balsamorhiza sagittata* was classified as the most fire resistant, "very fire resistant" in the study of the susceptibility of forbs to fire.[3]

INFORMATION SOURCES

References:

1 Kat, Anderson. 2006. Tending the Wild: Native American Knowledge and the Management of California's Natural Resources. University of California Press, Berkeley, CA.

2 Lady Bird Johnson Wildflower Center. 2011. Austin, Texas 78739. URL: http://www.wildflower.org/plants/result.php?id_plant=BASA3 (accessed 15 April 2011).

3 McWilliams, Jack. Balsamorhiza sagittata. 2002. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. URL:http://www.fs.fed.us/database/feis/plants/forb/balsag/all.html (accessed 15 April 2011).

4 Skinner, David M. 2004. Propagation protocol for production of container Balsamorhiza sagittata (Pursh) Nutt. plants; USDA NRCS - Pullman Plant Materials Center, Pullman, Washington. In: Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 17 April 2011).

5 Stanton, Frank. 1974. Wildlife guidelines for range fire rehabilitation.

	Denver, CO: U.S. Department of the Interior, Bureau of Land Management. 90 p. [2221] 6 US Forest Service. 2011.URL: http://www.fs.fed.us/r1/clearwater/LewisClark/lewis_clark_plants/LC_photos/forb_yellow/balssagi.htm. (accessed 15 April 2011). 7 USDA, NRCS. 2004. The PLANTS Database,Version 3.5 National Plant Data Center, Baton Rouge, LA 70874-4490 USA. (http://plants.usda.gov) accessed 12 April 2011. 8 Young, James A., Evans, Raymond A. 1979. Arrowleaf balsamroot and mules ear seed germination. Journal of Range Management. 32(1): 71-74. [2658]
Other Sources Consulted:	9 Barner, Jim 2009. Propagation protocol for production of Balsamorhiza sagittata (Pursh) Nutt. seeds; USDA FS - R6 Bend Seed Extractory, Bend, Oregon. In: Native Plant Network. URL:http://www.nativeplantnetwork.org (accessed 17 April 2011).
Protocol Author:	Carey, Michael
Date Protocol Created or Updated:	04/19/11

The Following Appendix is the Propagation Protocol for *Balsamorhiza sagittata* produced in 2003