Plant Propagation Protocol for *Calochortus macrocarpus*
ESRM 412 – Native Plant Production
Protocol URL: http://courses.washington.edu/esrm412/protocols/CAMA5.pdf

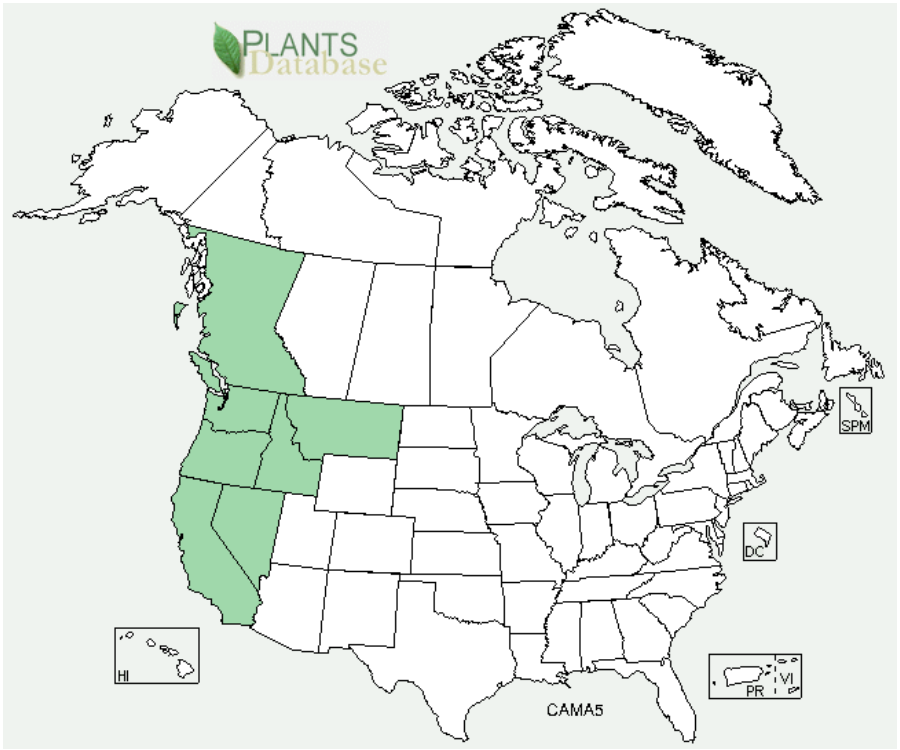
Source: [1]USDA PLANTS Database

TAXONOMY	
Plant Family	
Scientific Name:	Liliaceae
Common Name:	Lily Family
Species Scientific Name	
Scientific Name:	*Calochortus macrocarpus* Douglas
Varieties:	*Calochortus macrocarpus* var. *maculosus*[1] *Calochortus macrocaprus* var. *macrocarpus*[1]
Sub-species:	
Cultivar:	
Common Synonym(s):	*Calochortus acuminatus* Rydb.[2] *Calochortus cyaneus* A. Nelson[2] *Calochortus douglasianus* Schult f.[2] *Calochortus pavonaceus* Fernald[2] *Calochortus macrocarpa* (Douglas) Hoover[2]
Common Name(s):	Mariposa lily, Sagebrush mariposa lily, Nez Perce mariposa lily, Fowl Mannagrass, Sagebrush Mariposa Tulip, Green-banded mariposa lily[1,3,4]
Species Code:	CAMA5

GENERAL INFORMATION

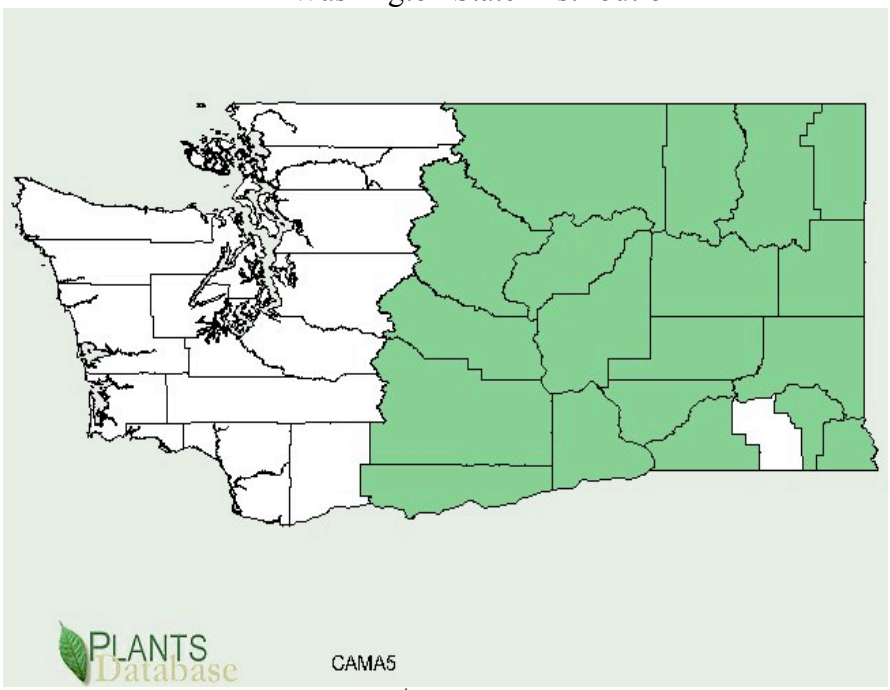
Geographical range	Western N. America

North American Distribution



Source: [1]USDA PLANTS Database

Washington State Distribution



Source: [1]USDA PLANTS Database

Ecological distribution:	Arid shrublands, grasslands and open forests in montane areas of the shrub-steppe.[3] Can also be found in open prairies, high deserts near sagebrush, and montane pine forests. Plants are found in the full sun in these areas and are often found in volcanic, ultramafic, or sandy soils.[4]
Climate and elevation range	Climate range is narrow. Populations are found in areas that have dry summers with high temperatures getting up to 110°F (43°C) and dry winters with minimal snow cover that can have temperatures as low as -30°F (-34°C). Annual precipitation is about 15 inches (38cm).[4] Elevation ranges from 250m[3] to 2700m[4]; 300-1370m in Washington[6]
Local habitat and abundance:	Commonly found in dry, loose, sandy/rocky soils. Can be found among sagebrush species, *Allium* species, *Pinus ponderosa*, *Eriogonum* species, *Achillea millefolium*, grasses, *Lupinus sericeus*, junipers, *Eriophyllum* species, *Agropyron spicatum, Balsamorrhiza sagittata, Festuca idahoensis, Pseudoroegneria spicata*, and many other native forbs of the dry sagebrush steppe.[5,6]
Plant strategy type / successional stage	Adapted to very dry environments and is highly intolerant of wetness, especially in winter; easily rots with too much water.[7,8] Tolerant of the cold but only if dry, and is heat tolerant.[7,8] Intolerant of shade[7]
Plant characteristics	Perennial dry shrub-steppe herb with a geophyte life form[6,9] Erect, stout and sturdy, unbranched stem arising from basal bulblets.[6] Usually a single leaf that has the edges rolled in and the tip curled; often withers by bloom time.[6,12] Flowers are distinguished by their light purple color with a conspicuous reddish/purple lateral band on the inside of the petals just above the gland. They also have a pale green band running lengthwise on the outside of the petals.[3,6] Fruits are erect linear-lanceolate capsules with a pointed tip and 3 sharp angles, but not winged.[6]
PROPAGATION DETAILS (Seeds)	
Ecotype:	BLM, Burns District, Hines, Oregon; 4155 ft. elevation[14] (If the information below describes the ecotype, it is specified within the text.)
Propagation Goal:	Seeds or Bulbs
Propagation Method:	Seed
Product Type:	Plug
Stock Type:	Propagules
Time to Grow:	Growing from seeds is a long process that can take 3-5 years; 5-7 years before the plant will flower.[7,8,11]

Target Specifications:	Mature, ripe seeds are ideal for propagation of this species.[11,13] After flowering, when vegetation dies back in late summer, the 3-5 year old dormant bulbs are divided and used to propagate.[7,8,10,11]
Propagule Collection:	Seeds can be collected in mid to late summer,[7,10] around late August to early September.[13] Seeds are easily collected when the capsule has fully matured and is dehiscing at the apex. Can be hand collected by pouring seeds right out of the capsule into paper[13] or cloth[11] bags and are clean of chaff.[13] Seeds are flat and inflated yellow/tan in color.[12] Collection should be prompt because few capsules survive long enough to maturity and have the opportunity to release seed due to deer eating them.[9] Typically 0.17 pounds of seeds are collected from a small lot.
Propagule Processing/ Propagule Characteristics:	Seed density was stated as 377,010 seeds/kg.[13] 222,350 seeds/lbs is stated for the ecotype.[14] Seed longevity is unknown, but viability by tetrazolium tests were 86%.[13] X-raying 100 ecotype seeds revealed 83% viability.[14]
Pre-Planting Propagule Treatments:	If seeds are poured into a paper bag, then they are free of chaff, but need to be blown by air to 10mm to remove any empty, nonviable seeds.[11] Ecotype seeds can also be air-screened using an office Clipper to accomplish the same thing; top screen: 1/16" x ¼" slot (2nd run with 1/16" x ½" cross slot) and a bottom screen: blank, medium speed, and low to medium air.[14] Cold stratification for 6-8 weeks is required; especially for those growing them in mild climates.[11] This can be done in their pots with growing medium or in a Ziploc bag with moist vermiculite. Stratification should be done in late fall so they will germinate in mid-winter to early spring. If stratified in their pots, mimic snow melt by covering the soil with ice cubes at just above freezing in a refrigerator. If they are stratified in moist vermiculite then they must be transplanted as soon as they germinate.[11]
Growing Area Preparation / Annual Practices for Perennial Crops:	The best growing medium has been found to be UC Davis mix which consists of ½ sand and ½ sphagnum peat moss.[11] The second best is UC Davis soilless consisting of 1/3 perlite, 1/3 vermiculite, and 1/3 sphagnum moss.[11] In the ground, the best results have been in clay soil as long as it is well drained and besides the minimal watering is kept dry.[11] Growing medium must be well drained.[4,7,8,10,11,13] Fertilizers like Lilly-Miller "Bulb & Bloom" and "Miracle-Gro" have been shown to work well.[11] No suggested size of containers, but they should be large enough that the plants can grow for 2 years without being disturbed[7,8,11] and tall enough that there is adequate drainage.

Establishment Phase:	Start by sowing seeds ¼" deep; ½" and ¾" have also shown to be effective planting depths.[11] Cold stratification should then be preformed (see above) to promote germination. It is recommended to give them an inch of water[3] once a week[11] until seedlings are ¾ -1 inch tall,[3,11] and then an inch of water every two weeks (less if in an area with frequent fog or overcast.[3,11] A thin layer of tiny pebbles or bark chips can be placed on top of the soil to reduce the chance of seeds to float or being dislodged. Bottom watering has been shown to be effective and prevents floating and dislodgeing.[11]
Length of Establishment Phase:	1-6 months,[7,8] but has been documented to take 4 months (late Sept to late March).[13]
Active Growth Phase:	Germinates should be started in pots or flats with growing medium, after 1-2 years they should be transplanted to soil.[7,8] Seedlings should remain undisturbed or transplanted for the first year[11] or two.[7] Whether they are transplanted or not, they should be allowed to grow for another 1-3 years.[7,8,11] Once plants have reached ¾ - 1 inch tall, plants should only be watered twice a month.[11] The single leaf will begin to wither and die, then the remaining vegetation; this is a sign that dormancy is beginning.[4,11,13]
Length of Active Growth Phase:	3-5 years[7,8,11]
Hardening Phase:	No hardening is required, but bulbs should be dormant prior to outplanting.[8] Dormancy will generally be between summer to mid-fall.[11]
Length of Hardening Phase:	Immediate during dormancy up to a year when the next dormancy period has been reached.[7,11]
Harvesting, Storage and Shipping:	Seeds or dormant bulbs for outplanting should be kept in cold, dry conditions[7,8]; 33-38^{o}F is suggested.[14]
Length of Storage:	Ready bulbs can be stored from late summer through the winter to the following spring before being planted.[7,8]
Guidelines for Outplanting / Performance on Typical Sites:	Seeds can be sown in the manner described above. Bulbs should be outplanted in late fall[13] or within the cold frame of spring.[7,8] Planting time can vary among species and is difficult to judge unless one lives in or near the species indigenous zones.[11] Seedlings can tolerate ½"-1" spacing, but will eventually require more space.[11] Ideal spacing is not suggested.

	Can take 3-5 years to flower from a mature seedling.[13,14]
Other Comments:	Soon after foliage dies back, bulbs can be divided for propagule use.[7,8,10,11] For the ecotype seeds, small lot collection presents a cleaning and testing challenge, and results may not be typical.[14] *Calochortus macrocarpus* var. *maculosus*[1] is State Endangered, BLM sensitive, and USFS sensitive.[6]
PROPAGATION DETAILS (Bulbs)	
Propagation Goal:	Seeds or Bulbs
Propagation Method:	Vegetative
Product Type:	Propagules
Stock Type:	3- or 5-gallon pots[11]
Time to Grow:	A season; from late winter through a year to the following cold frame of spring.[7,8]
Target Specifications:	Mature, ripe seeds.[11,13] Dormant bulbs. Bulbils for immediate planting.[7,8]
Propagule Collection:	Bulbs should not be collected from the wild because they rarely survive.[13] Bulbs should be obtained from plants that were started by seed and cultivated. Soon as flowering the foliage of the plant will die back in late summer and the bulbs/bulbils can be collected for propagation use.
Propagule Processing/Propagule Characteristics:	Characteristics not available.
Pre-Planting Propagule Treatments:	None.
Growing Area Preparation / Annual Practices for Perennial Crops:	The best growing medium has been found to be UC Davis mix which consists of ½ sand and ½ sphagnum peat moss.[11] The second best is UC Davis soilless consisting of 1/3 perlite, 1/3 vermiculite, and 1/3 sphagnum moss.[11] In the ground, the best results have been in clay soil as long as it is well drained and besides the minimal watering is kept dry.[11] Growing medium must be well drained.[4,7,8,10,11,13] Bulbs need large pots and they prefer 3- or 5- gallon pots.[11]
Establishment Phase:	Bulbs should be planted at a depth of 3”-4” in pots. At least a one-gallon pot for three bulbs.[11] Growers with mild wet winters will need to protect the plants by growing them in pure sand or covering them to block most of the rain.[4] The bulbs need to stay cold and dry for the first part of winter.[4]

	It is recommended to give them an inch of water[3] once a week[11] until seedlings are ¾ -1 inch tall,[3,11] and then an inch of water every two weeks (less if in an area with frequent fog or overcast.[3,11]
Length of Establishment Phase:	Not specified, but less than a year from planting.
Active Growth Phase:	Once plants have reached ¾ - 1 inch tall, plants should only be watered twice a month.[11] The single leaf will begin to wither and die, then the remaining vegetation; this is a sign that dormancy is beginning.[4,11,13]
Length of Active Growth Phase:	Bulbs generally grow in a short season from late winter to early summer.[4]
Hardening Phase:	No hardening is required, but bulbs should be dormant prior to outplanting.[8] Dormancy will generally be between summer to mid-fall.[11]
Length of Hardening Phase:	At least 1 year
Harvesting, Storage and Shipping:	Seeds or dormant bulbs for outplanting should be kept in cold, dry conditions[7,8]; 33-38°F is suggested.[14]
Length of Storage:	Ready bulbs can be stored from late summer through the winter to the following spring before being planted.[7,8]
Guidelines for Outplanting / Performance on Typical Sites:	Seeds can be sown in the manner described above. Bulbs should be outplanted in late fall[13] or within the cold frame of spring.[7,8] Planting time can vary among species and is difficult to judge unless one lives in or near the species indigenous zones.[11] Bulbs prefer 3”-4” of spacing between them, but if they are fertilized they can tolerate less space.[11] Can take 2 years for bulbs to flower.[8]
Other Comments:	Most bulbs collected from the wild are not successful in being transplanted.[13] Collection from the wild is actually discouraged and illegal because it kills the entire plant.[13] *Calochortus macrocarpus* var. *maculosus*[1] is State Endangered, BLM sensitive, and USFS sensitive.[6]
INFORMATION SOURCES	
References:	1. USDA, NRCS. 2014. The PLANTS Database (http://plants.usda.gov, 4 May 2014). National Plant Data Team, Greensboro, NC 27401-4901 USA 2. The Plant List**.** 2013. Version 1.1. Published on the Internet; http://www.theplantlist.org/ [Accessed May 12, 2014].

3. In Klinkenberg, Brian. (Editor) 2013. *E-Flora BC: Electronic Atlas of the Plants of British Columbia* [eflora.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. [Accessed: 5/12/2014] http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Calochortus%20macrocarpus

4. Pacific Bulb Society, 2013. *Calochortus* Species Four. Available: http://www.pacificbulbsociety.org/pbswiki/index.php/CalochortusSpecies Four [Accessed: 12 May, 2014]

5. Consortium of Pacific Northwest Herbaria. 2013. Available: pnwherbaria.org [Accessed: May 12, 2014]

6. Department of Natural Resources. *Calochortus macrocarpus* Douglas var. *maculosus* Available: http://www1.dnr.wa.gov/nhp/refdesk/fguide/pdf/camam.pdf [Accessed: May 12, 2014]

7. Plants For A Future. 2012. *Calochortus macrocarpus* – Douglas. Available: http://www.pfaf.org/user/Plant.aspx?LatinName=Calochortus+macrocarpus [Accessed: 12 May, 2014]

8. Practical Plants. 2013. Cal*ochortus macrocarpus*. Available: http://practicalplants.org/wiki/Calochortus_macrocarpus [Accessed: 12 May, 2014]

9. Miller, M.T, Allen, G.A. Antos, J.A. 2004. Dormancy and flowering in two mariposa lilies (Calochortus) with contrasting distribution patterns. Canadian Journal of Botany. 82(12): 1790-1799.

10. Garden Guides. 2010. Sagebrush Mariposa Lily (Macrocarpus). Available: http://www.gardenguides.com/taxonomy/sagebrush-mariposa-lily-calochortus-macrocarpus/ [Accessed: 12 May, 2014]

11. McDonald H.P. (editor) The Calochortus Society Newsletter. 1990. Mariposa Vol. II, #1. Available: http://lasmmcnps.org/geoffburleigharchive/PDF/Mariposa/ Mariposa%20Vol.%202.pdf [Accessed: 12 May, 2014]

12. Jepson Flora Project (eds.) 2013. *Jepson eFlora*, Available: http://ucjeps.berkeley.edu/IJM.html, [Accessed: May 12, 2014]

13. Vance, N.C. 2010. Evaluation of Native Plant Seeds and Seeding in the East-Side Central Cascades Ponderosa Pine Zone. Available:

	http://www.fs.fed.us/pnw/pubs/pnw_gtr823.pdf [Accessed: 12 May, 2014] 14. Barner, Jim 2009. Propagation protocol for production of *Calochortus macrocarpus* Dougl. seeds; USDA FS - R6 Bend Seed Extractory, Bend, Oregon. In: Native Plant Network. URL: http://www.nativeplantnetwork.org [Accessed 20 May 2014]. Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.
Other Sources Consulted:	1. Turner, Mark. 2013. *Calochortus macrocarpus*. Available: http://www.pnwflowers.com/flower/calochortus-macrocarpus [Accessed: May 12, 2014] 2. Pacific Rim Native Plant Nursery. 2007. Available: http://www.hillkeep.ca/bulbs%20calochortus.htm [Accessed: May 12, 2014] 3. NPIN: Native Plant Database - Lady Bird Johnson Wildflower Center. 2008. *Calochortus macrocarpus.* Available: http://www.wildflower.org/plants/result.php?id_plant=CAMA5 [Accessed: May 12, 2014] 4. Palouse Prairie Foundation Plant Database. 2012. Available: http://dev.palouseprairie.org/plants/plantdb/PPFplants.php?USDA=CAMA5 [Accessed: May 12, 2014]
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Date Protocol Created:	05/20/14