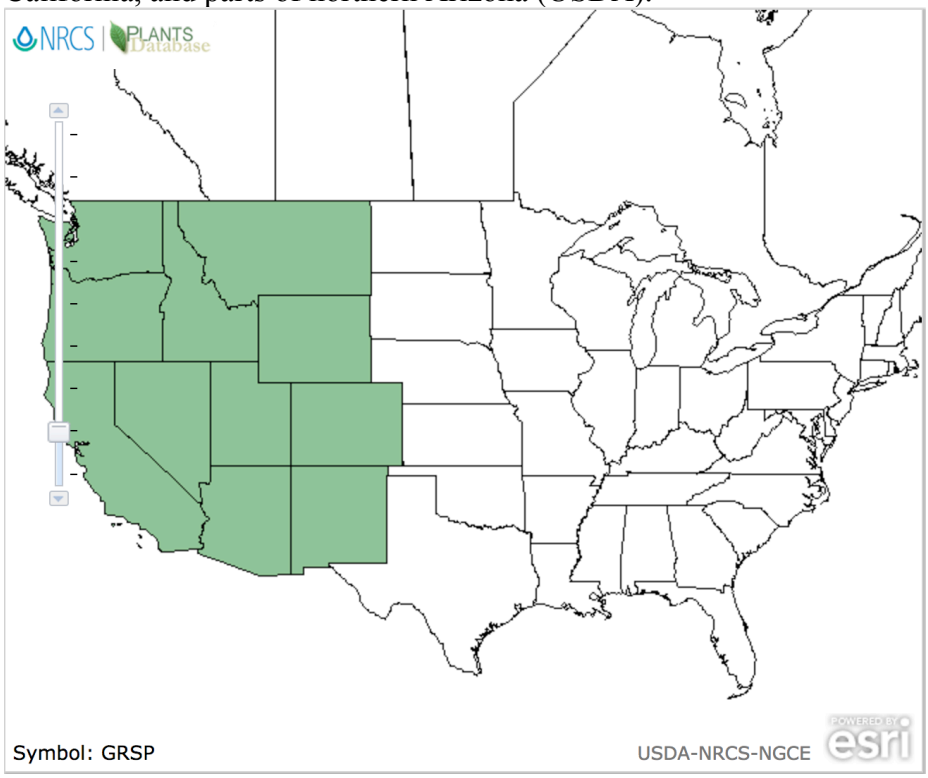
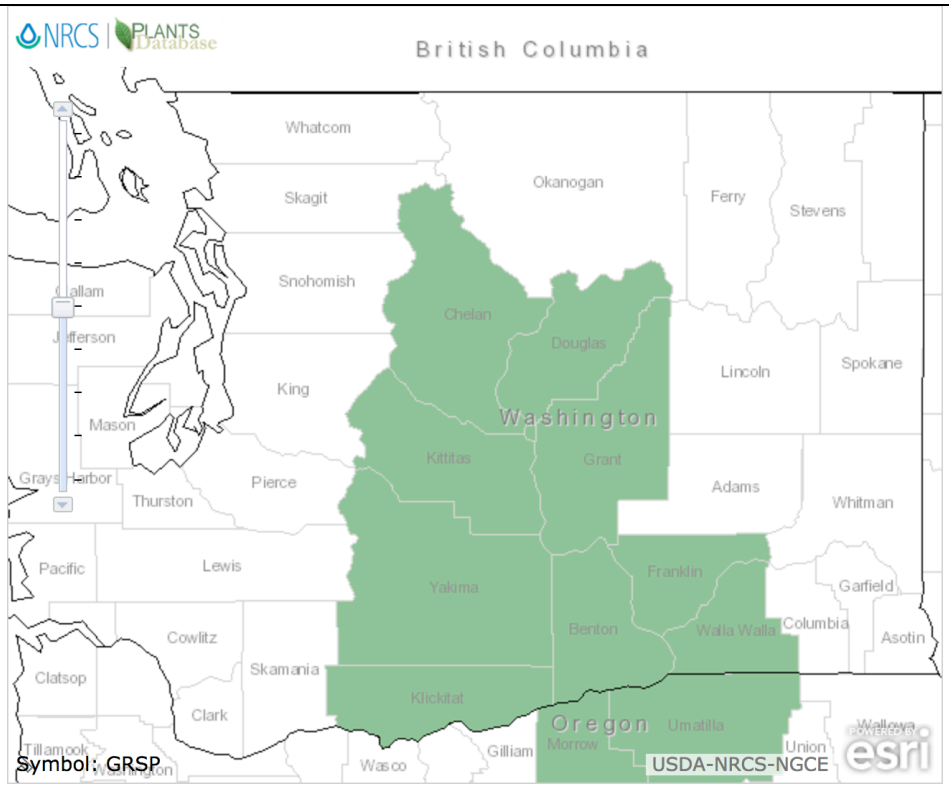
Plant Propagation Protocol for *Grayia spinosa*
ESRM 412 – Native Plant Production
Protocol URL: https://courses.washington.edu/esrm412/protocols/GRSP.pdf

Photo Credit: © 2008 Stan Shebs, California Native Plant Society

TAXONOMY	
Plant Family	
Scientific Name	Chenopodiaceae
Common Name	Goosefoot Family
Species Scientific Name	
Scientific Name	*Grayia spinosa* (Hook.) Moq.
Varieties	N/A
Sub-species	N/A
Cultivar	N/A
Common Synonyms	*Atriplex grayi* Collotzi ex W.A. Weber *Atriplex spinosa* (Hook.) Collotzi
Common Name(s)	Hopsage, Spiny hopsage, Applebush
Species Code	GRSP

(as per USDA Plants database)	
GENERAL INFORMATION	
Geographical range	Range is throughout all of the western United States, including central Washington, southeaster Oregon, most of Idaho, Wyoming, Utah, and Nevada, western Montana, parts of western Colorado, southwestern California, and parts of northern Arizona (USDA).  Source: USDA Plants Database

	 Source: USDA Plants Database
Ecological distribution	Grows in desert, dry plain, or dry foothill ecosystems; in sandy, dry, salt-free soils, commonly alkaline and limestone soils high in calcium (Utah State University). This species is not found in monoculture ecosystems. Leaf litter from this species is rich in potassium and will enhance the growth of surrounding plants (Shaw, Haferkamp, & Hurd 2008). This species is palatable for livestock and also provides nutrition and low-growing shelter for birds, rabbits, rodents, and other small animals (Shaw 1992). Dehydrated seeds were used by Native Americans to make pinole flour (Utah State University).
Climate and elevation range	Arid and semi-arid climates (Shaw 1992). Elevation range of 160 to 2,130 meters (Shaw, Haferkamp, & Hurd 2008).
Local habitat and abundance	Specifically associated with Wyoming big sagebrush, salt desert shrub, pinyon-juniper, Mojave Desert, and Great Basin-Mojave Desert communities (Shaw, Haferkamp, & Hurd 2008). Commonly associated species include Utah juniper (*Juniperus osteosperma*), Greasewood (*Sacrobatus* spp.), and Sandberg bluegrass (*Poa secunda*) (Utah State University).
Plant strategy type / successional stage	This species is drought-tolerant and has medium tolerance to fire and animal browse (Utah State University). This species is also salinity-tolerant (USDA); and shade-tolerant (Calflora). This species is associated with mid-successional communities (Shaw,

	Hafenkamp, & Hurd 2008).
Plant characteristics	Multi-branched, erect shrub with ascending or sprawling branches. Branches are stellate when young, and mature branches are dark gray in color. Leaves are oblong-lanceolate in shape and approximately 5-40 mm long; pubescent when young and turning glabrous with maturity (Abrams 1944). Leaves are gray-green in color and thick and fleshy in texture. Plants stand 0.3 to 1.5 meters tall at maturity (Shaw, Hafenkamp, & Hurd 2008). Flowers are typically dioecious and pistillate, clustered in dense terminal inflorescences. At maturity, flowers will turn pink to red, then die back after fruiting to green or yellow. The fruit is a small utricle (sac) contained in a thin, papery pericarp. The seed is small (about 1-2 mm in diameter) and disk-shaped (Shaw, Hurd, & Hafenkamp 1996). Flower blooming occurs in the late spring, and fruiting occurs in the summer. This species is slow-growing with a long lifespan (USDA).
PROPAGATION DETAILS (Propagation by Seed)	
Ecotype	Joshua Tree National Park, California: average of 250 frost-free days per year and annual rainfall of 5 to 10 cm (Graham 2004).
Propagation Goal	Plants (Graham 2004; Baskin & Baskin 2006).
Propagation Method	Seed (Graham 2004; Baskin & Baskin 2006).
Product Type	Container (plug) (Graham 2004; Baskin & Baskin 2006).
Stock Type	2-gallon PVC pipe container (Graham 2004).
Time to Grow	One year (Graham 2004).
Target Specifications	Dense, solid root plug (Graham 2004).
Propagule Collection Instructions	Hand-collect seeds at maturity, in June (Graham 2004). This can be accomplished by hand-stripping branches, or beating them with tennis rackets (Shaw, Hafenkamp, & Hurd 2008).
Propagule Processing/Propagule Characteristics	Seed density is 346,991 seeds per pound; seeds are extremely small and light (USDA).
Pre-Planting Propagule Treatments	Seeds can be preliminarily cleaned through a fine screen to remove coarse debris, then threshed (with a hammer-mill or barley de-bearder) to remove fine bracteoles, and finally put through another screen or seed-blower to remove remaining chaff (Shaw, Hafenkamp, & Hurd 2008). Seeds are initially stored in paper bags in a warm, dry room for 4-6 weeks, then transferred to cold, air-tight storage at 7° C after cleaning (Graham 2004). Seed dormancy is physiological, and seeds will require cold moist stratification (in a cycle of 15°C day and 5°C night) before planting. (Baskin & Baskin 2006).
Growing Area	Flats are used for germination; growing media for germination is not specified

Preparation / Annual Practices for Perennial Crops	(Graham 2004).
Establishment Phase Details	Germination occurs in a germination chamber or misting chamber, and takes approximately 2-3 weeks. After germination, successful germinants are transplanted to newspaper cylinders covered with polyvinyl food wrap (29 cm tall, 7.5 cm in diameter). The media used in the newspaper cylinders is 2:1:1 sand, mulch, and perlite (Graham 2004). Seeds planted 0.5 cm deep in soil is found to have the best germination results for this species (Wood, Knight, & Young 1976).
Length of Establishment Phase	4 weeks (Graham 2004).
Active Growth Phase	When ready for transplanting, the polyvinyl wrap is removed from the newspaper cylinders and the entire newspaper container is transplanted to 2-gallon PVC pipe containers (37.5 cm tall, 15 cm in diameter), filled with the same media as the newspaper cylinders (2:1:1 sand, mulch, and perlite). Fertilization is done with Osmocote time-release fertilizer at a 9 mo rate with a concentration of 22 grams per 6 liters. The transplanted seedlings are moved outdoors, in full sun except for the summer months when they are covered with a 55% shadecloth. Drip irrigation is used on the seedlings, with specific water amounts depending on weather conditions (Graham 2004).
Length of Active Growth Phase	9 months (Graham 2004).
Hardening Phase	Shadecloth is removed in October, after hot summer temperatures have passed, and for 4-8 weeks prior to outplanting seedlings are given lower frequency and duration of drip irrigation (Graham 2004).
Length of Hardening Phase	2 months (Graham 2004).
Harvesting, Storage and Shipping	Containerized seedlings are overwintered in outdoor growing facility where they are outplanted (Graham 2004).
Length of Storage	Storage length varies depending on time of outplanting (Graham 2004).
Guidelines for Outplanting / Performance on Typical Sites	In one study, 20% of seedlings (1 out of 5 total seedlings planted) was found to survive for one year on an outplanting site in the Mojave Desert (Ackerman 1979).
Other Comments	N/A

INFORMATION SOURCES	
References	Abrams, Leroy. 1944. *Illustrated Flora of the Pacific States: Washington, Oregon, and California; Volume II: Polygonaceae to Krameriaceae.* Stanford University Press. Print. Ackerman, Thomas. 1979. "Germination and survival of plant species in the Mojave Desert." *The Southwestern Naturalist,* 24(3), 399-408. Web. Retrieved from http://www.jstor.org/stable/pdf/3671296.pdf?refreqid=excelsior:710a440f43128cbf5bfbef563277e2ab. Accessed 20 May 2017. Baskin, Jerry & Carol Baskin. 2006. "Propagation protocol for production of container (plug) *Grayia spinosa* (Hook.) Moq. plants." University of Kentucky, Lexington, Kentucky. From: U.S. Department of Agriculture, Forest Service, National Center for Reforestation, Nurseries, and Genetic Resources, Native Plant Network. Web. Retrieved from https://rngr.net/npn/propagation/protocols/chenopodiaceae-grayia-1731/?searchterm=grayia%20spinosa. Accessed 20 May 2017. Calflora. N.d. "*Grayia spinosa.*" Calflora Database, Plant Characteristics and Associations. Web. Retrieved from http://www.calflora.org/entry/plantchar.html?crn=3955. Graham, Jean. 2004. "Propagation protocol for production of container (plug) *Grayia spinosa* (Hook.) Moq." U.S. Department of the Interior, National Parks Service, Joshua Tree National Park Native Plant Nursery Twentynine Palms, California. From: U.S. Department of Agriculture, Forest Service, National Center for Reforestation, Nurseries, and Genetic Resources, Native Plant Network. Web. Retrieved from: https://npn.rngr.net/npn/propagation/protocols/chenopodiaceae-grayia-2569/?searchterm=grayia%20spinosa. Accessed 20 May 2017. Shaw, Nancy. 1992. "Germination and seedling establishment of spiny hopsage (*Grayia spinosa* (Hook.) Moq.)." Oregon State University, Doctoral Dissertation. Web. Retrieved from http://search.proquest.com.offcampus.lib.washington.edu/docview/303994257. Accessed 20 May 2017. Shaw, Nancy; Haferkamp, Marshall; & Emerenciana Hurd. 2008. From *The Woody Plant Seed Manual.* USDA Forest Service, Agricultural Handbook No. 727. Web. Retrieved from https://www.fs.fed.us/rm/pubs_other/wo_AgricHandbook727/wo_AgricHandbook727_567_572.pdf. Accessed 20 May 2017. Shaw, Nancy; Hurd, Emerenciana; & Marshall Haferkamp. 1996. "Spiny hopsage fruit and seed morphology." *Journal of Range Management,* 49(6),

	551-553. Web. Retrieved from http://www.jstor.org.offcampus.lib.washington.edu/stable/4002298?sid=primo&origin=crossref&seq=1#page_scan_tab_contents. Accessed 20 May 2017. USDA Plants Database, N.d. "*Grayia spinosa* (Hook.) Moq. – Spiny hopsage." USDA Natural Resources Conservation Service. Web. Retrieved from https://plants.usda.gov/core/profile?symbol=GRSP. Accessed 20 May 2017. Utah State University Extension, N.d. "Spiny Hopsage." Utah State University Extension, Range Plants of Utah. Web. Retrieved from http://extension.usu.edu/rangeplants/htm/spiny-hopsage. Accessed 20 May 2017. Wood, M. Karl; Knight, Robert W., & James A. Young. 1976. "Spiny hopsage germination." *Society for Range Management,* 29(1), 53-56. Web.
Other Sources Consulted	Arbury, Jim et al. 1997. *The Complete Book of Plant Propagation.* The Taunton Press. Print. Hartmann, Hudson T. et al. 2015. *Plant Propagation: Principles and Practices,* Eighth Edition. Pearson Education, Inc. Print. Toogood, Alan R. 1999. *Plant Propagation.* American Horticulture Society, DK Publishing. Print.
Protocol Author	Thea Bucherbeam
Date Protocol Created or Updated	05-21-17