Plant Propagation Protocol for *Cercocarpus ledifolius*
ESRM 412 – Native Plant Production
Protocol URL: https://courses.washington.edu/esrm412/protocols/CELE3.pdf

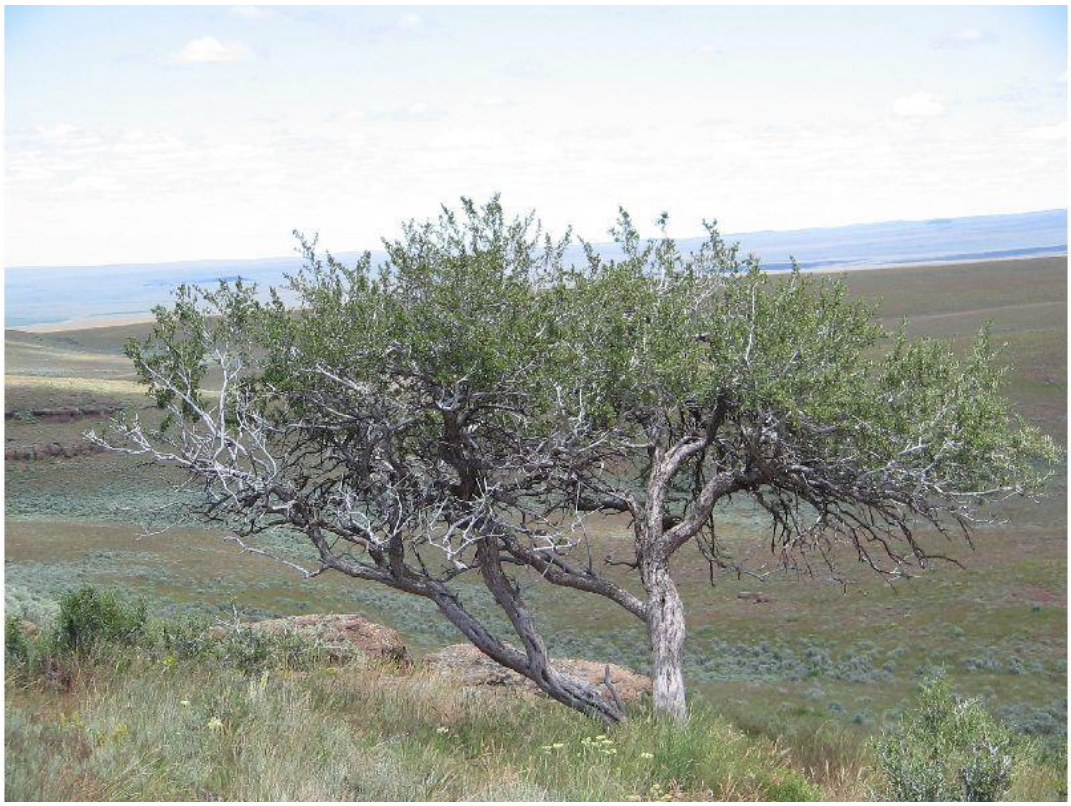
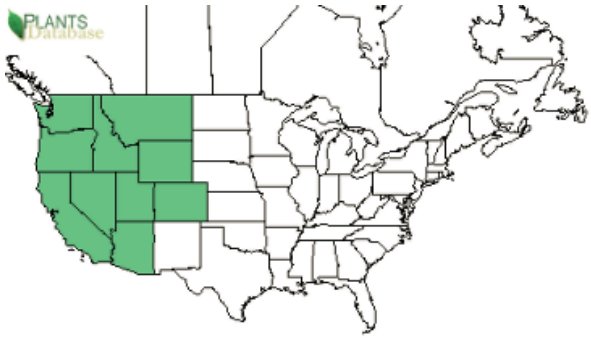


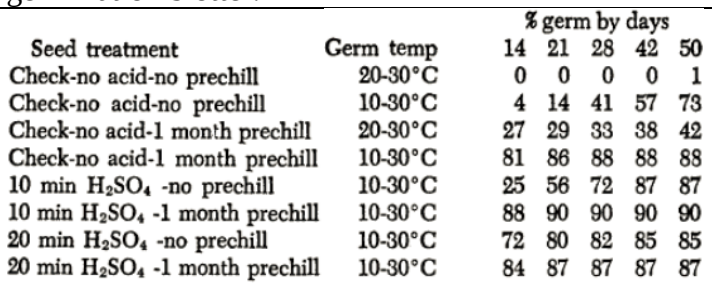
Photo by Sheri Hagwood, hosted by USDA Plants Database[12]

TAXONOMY	
Plant Family	
Scientific Name	Rosaceae[12]
Common Name	Rose family
Species Scientific Name	
Scientific Name	*Cercocarpus ledifolius* Nutt.[12]
Varieties	*Cercocarpus ledifolius* var. *intercedens* C.K. Schneid *Cercocarpus ledifolius* var. *ledifolius* Nutt.[12]
Sub-species	None recognized in USDA Plants Database.[12]
Cultivar	None.[12]
Common Synonym(s)	None.[8]
Common Name(s)	Curl-leaf mountain mahogany, curl-leaf mahogany, desert mountain mahogany[14]
Species Code (as per USDA Plants database)	CELE3[12]

GENERAL INFORMATION	
Geographical range	<u>North American distribution</u> Native to the Western United States.[12]  Map from USDA Plants Database[12] <u>Washington state distribution</u> Found in the southeastern corner of Washington state. Reported in Walla Walla, Columbia, Garfield, and Asotin counties by the USDA Plants Database.[12] A specimen cataloged in the University of Washington Herbarium database was also collected from Chelan county in 2012.[14]  Map from USDA Plants Database[12]
Ecological distribution	Present in dry, rocky areas of the Sierra and Rocky Mountains, as well as the Wyoming Basin, Grand Canyon, and Colorado Plateau. Occurs in sagebrush, pinyon-juniper, mountain brush, quaking aspen, and fir-spruce plant communities.[4]
Climate and elevation range	Found in areas with little rain and wide temperature ranges. Most common in areas with 15-26 inches of rain, but plants can tolerate as little as 10 inches of annual rain. Reported at elevations ranging from 2,000-9,800 feet, but typically found at 2,000-4,600 feet. Tolerates temperatures as low as -26ºC and as high as 35ºC.[4]

Local habitat and abundance	Grows in patterns ranging from patchy to dense. Often associated with Douglas fir, ponderosa pine, lodgepole pine, sagebrush, chaparral-mountain shrub, and pinyon-juniper, but does best in microsites with minimal vegetation.[4] Common on dry, rocky slopes that face south.[7]
Plant strategy type / successional stage	*C. ledifolius* is a pioneer species that grows in dry, rocky soils.[7] Seedlings establish best when the canopy is open and there is little leaf litter.[4] However, leaf litter increases the rates of seedling survival after establishment, possibly by increasing soil moisture.[6] The species' ability to grow in poor soils is likely due to its extensive root system and the presence of nitrogen-fixing bacteria in its root nodules. [1,13] The species also tolerates stresses such as temperature extremes.[4]
Plant characteristics	*C. ledifolius* may be a 1-2 m shrub or 4-10 m tree.[1] Plants are usually evergreen, but leaves may fall during a drought.[2] Leaves are dark green on the surface and whitish or light green on the underside. Leaves are 1-3 cm long and no more than 10 mm wide. Although leaf shape varies among populations, the leaf margin is always entire. Young branches are red or reddish-green and pubescent. As displayed in the photo below, older branches are grey and hairless.[14]  Photo by Cassondra Skinner, hosted by USDA Plants Database[12] The plant blooms between April and June, and then fruits mature in late summer.[1,14] As shown in the photo below, the fruit is an achene with a long, reddish-orange style with feathery, white hairs.[14]

	 Photo by Steve Hurst, hosted by USDA Plants Database[12] The roots have nodules that contain nitrogen-fixing bacteria of the genus *Frankia*.[13] The root system is extensive, and *C. ledifolius* is an excellent species to plant to control erosion on steep, rocky slopes.[1] Longevity varies with location. In Utah, the mean plant age in surveyed stands was 85 years, whereas this number was 352 years in Nevada.[1] One plant as old as 1,350 years was reported in Nevada![10]
PROPAGATION DETAILS	
Seeds, as described by Heit[5]	
Ecotype	Seeds collected from the Western United States.
Propagation Goal	Germinants
Propagation Method	Seed
Product Type	No product
Stock Type	Petri dish
Time to Grow	Seeds germinated in several days to 7 weeks.
Target Specifications	Maximum germination
Propagule Collection Instructions	Seed collected in the Western United States between 1959 and 1966 for United States Forest Service research.[5] The timing of fruit maturation varies considerably between individuals in a stand. Collect fruit between July and September by placing a tarp under a plant and shaking the branches. Wear eye protection while collecting and handling the fruit because hairs may blow off the fruit and into the eyes.[1]
Propagule Processing/Propagule Characteristics	The seed coat is permeable to water.[5] There was little information provided on the seed lot for this study, but another study found no significant difference between the germination percentages of seed stored for 2 versus 10 years when stored in an open warehouse with large temperature fluctuations. The

	study reported a germination percentage of 80% after 5 years of storage and 44% after 20 years of storage.[11]
Pre-Planting Propagule Treatments	To determine the best pre-planting treatment, the researchers manipulated the duration of sulfuric acid exposure and cold, moist stratification, as well as germination temperature conditions. Durations of sulfuric acid exposure were 0, 10, or 20 minutes. Durations of cold, moist stratification were 0, 1, 2, or 3 months. Germination temperature conditions were 25ºC, 20ºC, 15ºC, alternating between 20 and 30ºC, or alternating between 10 and 30ºC. The researchers also tested the effects of adding thiourea and potassium nitrate solutions to the germination blotter.
Growing Area Preparation / Annual Practices for Perennial Crops	Place seeds in a closed petri dish on a moist germination blotter.
Establishment Phase Details	 % germ by days Seed treatment / Germ temp / 14 / 21 / 28 / 42 / 50 Check-no acid-no prechill / 20-30°C / 0 / 0 / 0 / 0 / 1 Check-no acid-no prechill / 10-30°C / 4 / 14 / 41 / 57 / 73 Check-no acid-1 month prechill / 20-30°C / 27 / 29 / 33 / 38 / 42 Check-no acid-1 month prechill / 10-30°C / 81 / 86 / 88 / 88 / 88 10 min H_2SO_4 -no prechill / 10-30°C / 25 / 56 / 72 / 87 / 87 10 min H_2SO_4 -1 month prechill / 10-30°C / 88 / 90 / 90 / 90 / 90 20 min H_2SO_4 -no prechill / 10-30°C / 72 / 80 / 82 / 85 / 85 20 min H_2SO_4 -1 month prechill / 10-30°C / 84 / 87 / 87 / 87 / 87 Moistening the germination blotter with a solution containing thiourea and potassium nitrate did not increase seed germination percentage. There was no difference in the germination rates of seeds placed in cold, moist stratification for one, two, and three months. Seed germination was low in an environment that was 25ºC, 20ºC, 15ºC, or fluctuating between 20 and 30ºC. Cold, moist stratification, a sulfuric acid treatment, and a germination environment that fluctuated 20ºC in a 24-hour cycle increased germination rates and percentages.
Length of Establishment Phase	The majority of a seed lot germinates in 2 to 7 weeks, though the timeframe depends on the pretreatment. Seeds that received a sulfuric acid treatment and then one month of moist, cold stratification had the fastest germination rates, with more than 80% of seeds germinating within 2 weeks. Seeds with no sulfuric acid or stratification treatment had the slowest germination rates, with over 70% of seeds germinating

	in 7 weeks when the germination temperature alternated between 10 and 30ºC.
Active Growth Phase	Information not provided.
Length of Active Growth Phase	Information not provided.
Hardening Phase	Information not provided.
Length of Hardening Phase	Information not provided.
Harvesting, Storage and Shipping	Information not provided.
Length of Storage	Information not provided.
Guidelines for Outplanting / Performance on Typical Sites	Information not provided.
Other Comments	Seeds should be exposed to sulfuric acid for 10-20 minutes and then put in cold, moist stratification for 20-30 days at 3-5ºC. Place seeds in the light under an alternating 10-30ºC, 24-hour cycle for 2 weeks to germinate. The temperature fluctuation cycles are crucial for germination. Seed will not germinate without alternating temperatures. This is not surprising considering that there is a large difference between day and nighttime temperatures in the natural environment of the species.[5] Seeds may be nondormant or exhibit physiological dormancy. The length of cold, moist treatment required varies with the collection site and ranges from two to twelve weeks.[1]
Stem cuttings, as described by Everett, Meeuwig, and Robertson[3]	
Ecotype	Cuttings acquired from multiple stands in Nevada.
Propagation Goal	Plants
Propagation Method	Vegetative
Product Type	Container
Stock Type	Information not provided.
Time to Grow	No cuttings were successfully rooted.
Target Specifications	Rooted cuttings, with roots at least 1 cm long after 3 months on the mist bench.
Propagule Collection Instructions	Semihardwood cuttings were taken from flowering plants. Cuttings were submersed in water right after collection, and then transported to the greenhouse in wet newspaper and a Styrofoam box. Cuttings were struck within 3 days.
Propagule Processing/Propagule Characteristics	Cuttings measured 0.3-2.0 cm wide and 15-30 cm long.
Pre-Planting Propagule Treatments	Wound the basal end of cuttings. Dip the cuttings in a talc powder of 0.8% indole-3-butric acid before striking.

Growing Area Preparation / Annual Practices for Perennial Crops	Before placing cuttings on the mist bench, apply fungicide Captan-50 WP to the mist bench surface. The fungicide should be diluted with water to 0.41 g/L, and applied at 1.6 L/m^2 to the mist bench surface. Strike cuttings in coarse perlite. Place cuttings on a mist bench without bottom heat.
Establishment Phase Details	<table><tr><th>Total no. of cuttings</th><th>Mean % rooted</th><th>Range in % rooted</th><th>Rooting period (wks)</th></tr><tr><td>48</td><td>0</td><td>0</td><td>12</td></tr></table>
Length of Establishment Phase	No cuttings rooted after 3 months on the mist bench.
Active Growth Phase	Information not provided.
Length of Active Growth Phase	Information not provided.
Hardening Phase	Information not provided.
Length of Hardening Phase	Information not provided.
Harvesting, Storage and Shipping	Information not provided.
Length of Storage	Information not provided.
Guidelines for Outplanting / Performance on Typical Sites	Information not provided.
Other Comments	Although the researchers failed to root any cuttings, cuttings from the closely related species *C. intricatus* have been successfully rooted. This study experimented with the effect of different concentrations of liquid auxin on rooting success. Rooting was best with high auxin concentrations of 4000/2000 ppm indolebutryic acid/naphthaleneacetic acid. No or few cuttings rooted when low auxin concentrations of 2000/1000 ppm indolebutryic acid/naphthaleneacetic acid or no auxin was applied.[9] Future studies should investigate if the methods used to root cuttings of *C. intricatus* are successful for *C. ledifolius.* It is possible that the *C. ledifolius* cuttings failed to root in this case because the concentration of auxin applied was not high enough. Other possibilities for the lack of rooting could be the rooting media, the timing of cutting collection, or the watering regimen. Seed seems to be a more reliable method of propagation for *C. ledifolius* than cuttings. The study on *C. intricatus* cuttings found that rooting success varied considerably among sites when the same auxin concentration was applied.[9]

Effect of container size on seedling size, as described by Keyes and Brissette[7]	
Ecotype	Information not provided.
Propagation Goal	Plants
Propagation Method	Seed
Product Type	Container
Stock Type	Four different containers Styro-20: 15.2 cm deep, 336 cm^3 volume Styro-10: 15.2 cm deep, 164 cm^3 volume RL-10: 21.0 cm deep, 164 cm^3 volume Stubby-10: 11.7 cm deep, 125 cm^3 volume
Time to Grow	8 months
Target Specifications	Seedlings with large root collar diameters and root biomass, high total biomass, and low shoot to root ratios. Seedling size should also be uniform.
Propagule Collection Instructions	Information not provided.
Propagule Processing/Propagule Characteristics	Information not provided.
Pre-Planting Propagule Treatments	Sterilize and stratify seeds. No further details provided.
Growing Area Preparation / Annual Practices for Perennial Crops	Seeds were directly sown into four different types of containers: Styro-20, Styro-10, RL-10, and Stubby-10. See the stock type section for details on the dimensions of each container type. For each container type, eight cell trays were sown. Each container contained a 1:1 mix of peat moss and perlite. After sowing two seeds per container, the seeds were covered with a small amount of granite poultry grit. Seeds were started in the greenhouse at the University of Montana.
Establishment Phase Details	Both seeds germinated in half of the containers. Containers with two seedlings were thinned and the 5% of containers without any seedlings were removed.
Length of Establishment Phase	Information not provided.
Active Growth Phase	Plants were fertilized with Miracle-Gro 24-8-16 at 250 ppm nitrogen via fertigation. Seedlings were moved from the greenhouse to a shade house in June, where they remained until October. Container trays were rearranged each month to prevent small variations in the environment of different areas of the greenhouse and shade house from influencing results. Destructive measurements were taken for eight seedlings per tray in October at the end of the growing season. The shoot-root ratio was similar among the container types. Total seedling weight, shoot weight, root weight, root collar caliper, and shoot height was highest for

	seedlings grown in Styro-20 containers. Total seedling biomass divided by bedspace area was also highest for Styro-20 containers. However, uniformity in seedling size was lowest for seedlings grown in Styro-20 containers. Total seedling biomass divided by the volume of the container used was similar for the largest container, Styro-20, and the smallest container, Stubby-10. Seedlings were smallest in the RL-10 containers, which were the narrowest container type, even though seedling size was uniform.
Length of Active Growth Phase	March to October
Hardening Phase	Information not provided.
Length of Hardening Phase	Information not provided.
Harvesting, Storage and Shipping	Information not provided.
Length of Storage	Information not provided.
Guidelines for Outplanting / Performance on Typical Sites	Plant on dry mountainous slopes that face south. Performs well in nutrient poor soils. Seedlings should have well-developed root systems before outplanting.
Other Comments	To grow the largest, most robust seedlings, the best container type is Styro-20. On the other hand, if uniformity in seedling size is more important than large seedling biomass, RL-10 containers should be used.
INFORMATION SOURCES	
References	See below.
Other Sources Consulted	See below.
Protocol Author	Kyra Kaiser
Date Protocol Created or Updated	05/12/18

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