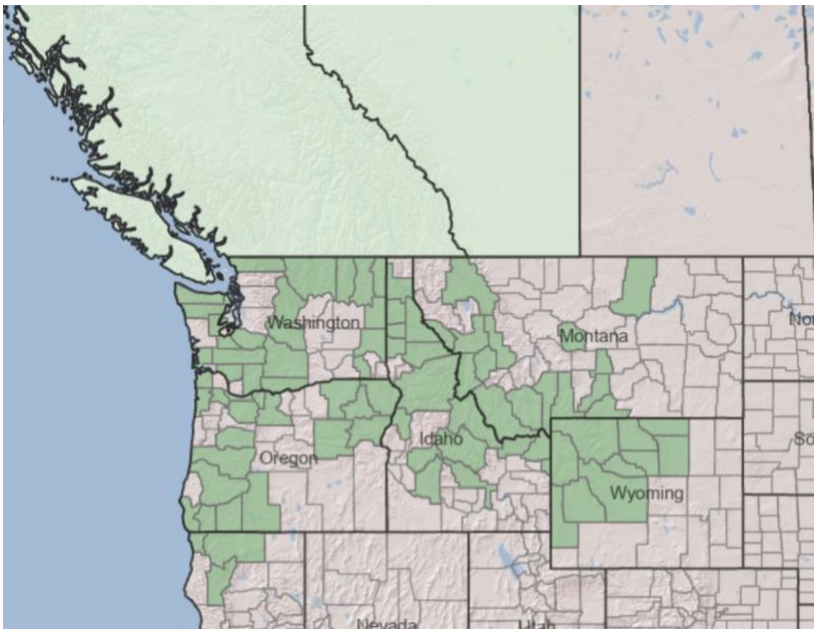
Plant Propagation Protocol for *Antennaria racemosa* Hook.
ESRM 412 – Native Plant Production
URL: https://courses.washington.edu/esrm412/protocols/*2024/ANRA.pdf*

(Left is Gerald D. Carr 2006 & Right is Ben Legler 2005 from the Burke Herbarium Image Collection)[6]

TAXONOMY	
Plant Family	
Scientific Name	Asteraceae[1]
Common Name	Aster[1]
Species Scientific Name	
Scientific Name	*Antennaria racemosa* Hook.[1]
Varieties	N/A
Sub-species	N/A
Cultivar	N/A
Common Synonym(s)	*Antennaria petasites* Greene, *Antennaria piperi* Rydb.[1]
Common Name(s)	Raceme pussytoes[1] Racemose pussytoes[3]

Species Code (as per USDA Plants database)	ANRA[1]
GENERAL INFORMATION	
Geographical range	Ranges throughout mountain areas in British Columbia down south to California, and east to Alberta, Montana, and Wyoming[3/4/5]  (Esri 2014 from USDA database)[1]
Ecological distribution	Distributed on moist to dry rocky north facing slopes, forest openings, and ledges[6]
Climate and elevation range	**Temperature Range**: 47 °F to 58 °F with high of 86 °F and low of 28 °F[3] **Elevation Range**: One resource[3] suggested the elevation range to be 3150 ft to 6465 ft while another states that this species is found anywhere from low elevation to Alpine elevations[6].
Local habitat and abundance	Found to grow in forested areas, often containing Douglas-fir, Fir – spruce, Hemlock - Sitka spruce, Larch, Lodgepole pine[2]. Occasionally found in meadows; valleys to subalpine.[9] *A. racemosa* is known to associate with plants like bearberry (Arctostaphylos uva-ursi), prince's pine (Chimaphila umbellata), twinflower (Linnaea borealis), grouse whortleberry (Vaccinium scoparium), heartleaf arnica (Arnica cordifolia), western yarrow (Achillea millefolium), fireweed (Epilobium angustifolium), fleabane (Erigeron spp.), showy aster (Aster conspicuus), dandelion (Taraxacum officinale), scarlet paintbrush (Castilleja miniata), Virginia strawberry (Fragaria virginiana), and pinegrass (Calamagrostis rubescens)[2]. This plant is also seen to have a moderate foraging value to deer and generally increases when trampled[2].

Plant strategy type / successional stage	*A. racemosa* is categorized as a facultative seral species. Ideal for early succession and does well with disturbances[2]. Found to be shade tolerant even though it is often found on north facing slopes and has a tolerance to low amounts of water[6/3.] This plant has also been seen to tolerate moderate trampling, along with increase growth in response to grazing.[2]
Plant characteristics	Forb; perennial; stem ranges from 4 to 24 inches tall, coming from creeping and leafy stolons. Stems are strongly glandular in upper portion. Basal leaves are short-petiolate with an elliptic to elliptic-ovate blade that is 1.5-8 cm long and 1-5 cm wide. Leaves are white-woolly underneath and green and glabrous above. Flowers are on heads with slender peduncles in a narrow raceme-like inflorescence. Staminate involucres are 4-5 mm high, but wider than the pistillate; pistillate 6- 8 mm high and strongly imbricate, the inner bracts narrow and elongated. These bracts tend to be pale greenish below and transition to colorless and transparent to pale brownish on top. Flowers may be more crowded in an inflorescence together depending on elevation[4/5/6]. Blooms from May to August[4].
PROPAGATION DETAILS: From Seed	
Ecotype	In fescue grassland near Two Medicine in Glacier National Park[7]
Propagation Goal	Plants
Propagation Method	Seed
Product Type	Container (plug)
Stock Type	172 mL container
Time to Grow	4 months
Target Specifications	For plants to have a height of 2 cm with about 6-10 true leaves and for the root system to have a firm plug in the container. [7]
Propagule Collection Instructions	Seeds were collected in June to July; however, this may vary as this information is referenced from a close relative (Antennaria rosea Greene) of *Antennaria racemosa* Hook. It is observed that *Antennaria racemosa* Hook blooms later, until August[4], so time for seed collection may vary. Collection can occur when achenes can be easily separated from the receptacle of the plant. Once seeds have reached maturity, collect, and place in paper bag where they have ventilation[7].
Propagule Processing/Propagule Characteristics	Seeds were cleaned with a hammermill and then ran over with an office clipper. Storing can occur after this point and may occur up to 5 years sealed in a container at 3 to 5 °C. Seed dormancy is classified as nondormant, but seed timing may vary due to species[7]. Seeds/Kg: 14,520,000/Kg % Purity: 100% % Germination: 80% to 98%[7]
Pre-Planting Propagule Treatments	No stratification is needed on the dry stored seeds. Seeds can be sown in the outdoor nursery in late fall and are then subjected to a 5-month outdoor cold moist stratification[7].
Growing Area Preparation / Annual	**Growing Area**: In an outdoor growing facility. **Sowing Method**: Direct seeding where seeds are sown on surface of media.

Practices for Perennial Crops	**Growing medium**: Milled sphagnum, perlite, and vermiculite with Micromax fertilizer (12% S, 0.1% B, 0.5% Cu, 12% Fe, 2.5% Mn, 0.05% Mo, 1% Zn) and Osmocote control release fertilized (13N:13P2O5:13K2O; 8-to-9-month release rate at 21 °C). Rate used was 0.20 gram of Micromax and 1 gram of Osmocote per 172 ml container. Containers were filled and sown in late fall and irrigated thoroughly prior to winter[7].
Establishment Phase Details	Seedlings of Antennaria appear to germinate more slowly than most forb species, which may vary. Germination for this experiment continued over a 21-day period. Once germination has occurred and seedlings have their true leaves thinning should occur.[7]
Length of Establishment Phase	4 weeks[7]
Active Growth Phase	Once seedlings are established, plants will have rapid shoot and root growth for 4 weeks following germination. Plants should then be fertilized with 13-13-13 liquid NPK at 100 ppm bi-weekly during the growing season. Plants are mat forming and will quickly fill containers during this phase.[7]
Length of Active Growth Phase	8 weeks[7]
Hardening Phase	At this stage plants should be fertilized with 10-20-20 liquid NPK at 200 ppm which should be early fall. Plants are watered by leaching water into pots. Irrigation can be reduced through September and October[7].
Length of Hardening Phase	4 weeks[7]
Harvesting, Storage and Shipping	The total time to harvest was 4 months where July was the harvest date. Storage conditions consisted with overwintering in the outdoor nursery under insulating foam and snow[7].
Length of Storage	5 months[7]
Guidelines for Outplanting / Performance on Typical Sites	No information was provided about outplanting. Seems that once winter is over plants could be planted at site. Timing will vary on sight and snow amounts. However, if direct seeding at restoration sites does occur then seeds must be rolled or pressed into prepared seed beds. Ranking or burying the seeds will result in poor establishment[7].
Other Comments	Seeds require light during germination. Vegetative Propagation Method is optional after this with stock plants. Division of established nursery stock could produce more. Especially if there are not enough seeds available[7].
PROPAGATION DETAILS: VEGETATIVE	
Propagation Goal	Plants or Seed[7]
Propagation Method	Vegetative[7/8]
Product Type	Container (plug)[7] Propagation through breaking up mat and cutting stolons[7]
Stock Type	If container is used, then 172 mL[7]
Time to Grow	0[8]
Propagule Collection Instructions	Vegetative propagation is possible with established nursery stock, which can be grown from seed.[7]

Pre-Planting Propagule Treatments	No extra treatment is indicated[7/8]
Growing Area Preparation / Annual Practices for Perennial Crops	Can use either an outdoor growing facility or direct planting at site may be possible as well. Mist or irrigate, but no need for tenting[8]. Growing media recommended is milled sphagnum, perlite, and vermiculite with fertilizer. Container size depends on desired propagation cutting. 172mL containers were used in past growing experiments, which should work.[7]
Active Growth Phase	Plants should then be fertilized with 13-13-13 liquid NPK at 100 ppm bi-weekly during active growth[7].
Length of Active Growth Phase	8 weeks[7] May take longer, this is based on seed active growth as there is not enough information on this.
Hardening Phase	At this stage plants should be fertilized with 10-20-20 liquid NPK at 200 ppm which should be early fall. Plants are watered by leaching water into pots. Irrigation can be reduced through September and October[7].
Length of Hardening Phase	4 weeks[7] Based on seed hardening information.
Guidelines for Outplanting	If the vegetative propagation is directly planted at outplanting site, then provide misting of some kind until establishment[8]. Besides that, much is mentioned about outplanting guidance.
Other Comments	Luna et al. (2008) suggests growing from seed and then vegetatively propagating if less seeds are available as this can be used to produce more[7].
	INFORMATION SOURCES
References	1. *Antennaria racemosa Hook.* USDA plants database. (n.d.). https://plants.usda.gov/home/plantProfile?symbol=ANRA 2. Matthews, Robin F. 1993. Antennaria racemosa. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: https://www.fs.usda.gov/database/feis/plants/forb/antrac/all.html [2024, May 18]. 3. Calflora: Information on California plants for education, research and conservation, with data contributed by public and private institutions and individuals. [web application]. 2024. Berkeley, California:The Calflora Database [a non-profit organization]. Available: https://www.calflora.org/app/taxon?crn=385 (Accessed: 05/18/2024). 4. Hitchcock, C. Leo; Cronquist, Arthur. 1973. Flora of the Pacific Northwest. Seattle, WA: University of Washington Press. 730 p. [1168] 5. Lackschewitz, Klaus. 1991. Vascular plants of west-central Montana--identification guidebook. Gen. Tech. Rep. INT-227. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 648 p. [13798] 6. Giblin, D., & Knoke, D. (n.d.-b). Antennaria racemosa - burke herbarium image collection. https://burkeherbarium.org/imagecollection/taxon.php?Taxon=Antennaria+racemosa

	7. Luna, Tara; Evans, Jeff; Wick, Dale; Hosokawa, Joy. 2008. Propagation protocol for production of Container (plug) Antennaria rosea Greene plants 172 ml containers; USDI NPS - Glacier National Park West Glacier, Montana. In: Native Plant Network. URL:https://npn.rngr.net/renderNPNProtocolDetails?selectedProtocolIds=asteraceae-antennaria-16 (accessed 2024/05/18). US Department of Agriculture, Forest Service, National Center for Reforestation, Nurseries, and Genetic Resources. 8. Butler, Jennifer; Frieswyk, Christin. 2001. Propagation protocol for production of Propagules (seeds, cuttings, poles, etc.) *Antennaria* Gaertn. plants USDI NPS - Rocky Mountain National Park Estes Park, Colorado. In: Native Plant Network. URL: https://npn.rngr.net/renderNPNProtocolDetails?selectedProtocolIds=asteraceae-antennaria-807 (accessed 2024/05/20). US Department of Agriculture, Forest Service, National Center for Reforestation, Nurseries, and Genetic Resources. 9. Lesica, P., Lavin, M. T., Stickney, P. F., Emery, C., McNiel, D., & Adams, R. (2022). Manual of Montana Vascular Plants. BRIT Press.
Other Sources Consulted	1. Bayer, R. J., Soltis, D. E., & Soltis, P. S. (1996). Phylogenetic inferences in Antennaria (asteraceae: Gnaphalieae: Cassiniinae) based on sequences from nuclear ribosomal DNA internal transcribed spacers (its). American Journal of Botany, 83(4), 516. https://doi.org/10.2307/2446220 2. Romme, W. H., Bohland, L., Persichetty, C., & Caruso, T. (1995). Germination ecology of some common forest herbs in Yellowstone National Park, Wyoming, U.S.A. Arctic, and Alpine Research, 27(4), 407. https://doi.org/10.2307/1552034
Protocol Author	Shea M. Molsee
Date Protocol Created	May 20, 2024