

Plant Propagation Protocol for *Pentagramma triangularis*
ESRM 412 – Native Plant Production

TAXONOMY	
Family Names	
Family Scientific Name:	Pteridaceae (1)
Family Common Name:	Brake family (3)
Scientific Names	
Genus:	<i>Pentagramma</i>
Species:	<i>triangularis</i>
Species Authority:	Kaulf, Yatsk, Windham, Wollenw, Maxon (1)
Variety:	NA
Sub-species:	<i>Pentagramma triangularis</i> (Kaulf.) Yatsk., Windham & E. Wollenw. ssp. <i>Triangularis</i> (1)
Cultivar:	NA
Authority for Variety/Sub-species:	NA
Common Synonym(s) (include full scientific names (e.g., <i>Elymus glaucus</i> Buckley), including variety or subspecies information)	PITR <i>Pityrogramma triangularis</i> (Kaulf.) Maxon (1) <i>Gymnogramme triangularis</i> <i>Pentagramma triangularis</i> ssp. <i>Semipallida</i> <i>Pityrogramma triangularis</i> (2)
Common Name(s):	Goldback fern, (1) Goldenback fern, (2)
Species Code (as per USDA Plants database):	PETRT
GENERAL INFORMATION	
Geographical range (distribution maps for North America and Washington state)	The distribution range from west of the Cascades to eastern Arizona, and north of Vancouver Island B.C to Baja California. (4) See Appendix Fig. 1 and Fig. 2 for map.
Ecological distribution (ecosystems it occurs in, etc):	Chaparral, grassland, forest, woodlands (2)
Climate and elevation range	0-7545 feet (2)
Local habitat and abundance; may include commonly associated species	PETRT can be found in many plant communities. In California, it is associated with coastal sage scrub, creosote brush scrub, yellow pine forest, chaparral, valley grassland and pinyon-juniper woodland (2). In Washington state, they are primarily found in rock crevices and open, dry rocky slopes in valleys and foothills (4). It can tolerate sun to partial shade (15).
Plant strategy type / successional stage	It tolerates wide range of elevations and soil types so it

(stress-tolerator, competitor, weedy/colonizer, seral, late successional)	is a stress-tolerator and could be an early colonizer (20).
Plant characteristics {life form (shrub, grass, forb), longevity, key characteristics, etc }	<p>It is a perennial evergreen herb (4).</p> <p>The rhizome is stout and creeping. The many fronds are clustered and triangular and can grow up to 35cm (6). The petioles are dark brown, glossy, and wiry. The blades are 2 or 3 times divided. The pinnae are the largest and most asymmetric at the base and become smaller and more symmetric toward the tip (19). When the weather is dry, the fronds curl up to reveal the white to golden sporangia lined along the veins. The sporangia do not have indusia (15). The plant can be 10-30 cm tall (7).</p> <p>See Fig. 3.</p>
PROPAGATION DETAILS: Spores	
Ecotype (this is meant primarily for experimentally derived protocols, and is a description of where the seed that was tested came from):	NA
Propagation Goal (Options: Plants, Cuttings, Seeds, Bulbs, Somatic Embryos, and/or Other Propagules):	Plants, sporophyte
Propagation Method (Options: Seed or Vegetative):	Spores
Product Type (options: Container (plug), Bareroot (field grown), Plug + (container-field grown hybrids, and/or Propagules (seeds, cuttings, poles, etc.))	Container
Stock Type:	spores
Time to Grow (from seeding until plants are ready to be outplanted):	3 to 4 months (9, 10)
Target Specifications (size or characteristics of target plants to be produced):	Sporophyte part of the life cycle.
Propagule Collection (how, when, etc):	<p>Temperate species can be collected from mid to late summer. Collect the fronds when the sori color darkens and a few sori are open (17).</p> <p>Spores can be collected from the underside of fronds. Place the fronds with ripe sporangia in a manila envelope in a warm and dry environment to let the</p>

	spores fall away (11, 12, 17).
Propagule Processing/Propagule Characteristics (including seed density (# per pound), seed longevity, etc):	<p>dry for a week at 21 C (11, 12, 17).</p> <p>To separate the spores from chaff, use a fine sieve or tip the dried contents onto a clean piece of paper. When the paper is held at 45 degree angle, the debris will slide down the paper faster than the spores (17).</p> <p>The spores can be stored in a vacuum-sealed bottle and stores in a dry cool place (9, 10). If vacuum seal is not available, the spores should be stored in a black plastic film canister containing a packet of desiccant to discourage dampness and mold. The spores should last 3-5 years if the canister is kept in a refrigerator at 39-41 F (4-5 C) (17).</p>
Pre-Planting Propagule Treatments (cleaning, dormancy treatments, etc):	<p>The spores are centrifuged in 2% Clorox solution to sterilize against algae, mosses, and fungi. Then the spores are spread evenly across a culture medium composed of MS salts, 3% sucrose, thiamin, 0.8% agar (17).</p> <p>The spore and bleach mix can also be shaken for 1 ½ minutes then filtered through a Buchner funnel using a vacuum. Then air-dry the spores (9, 10).</p> <p>If the spores are sterilized with 10% sodium hypochlorite solution, they should be drained, rinsed in sterile, boiled, and cooled water. Then the spores should be left to air dry (17).</p>
Growing Area Preparation / Annual Practices for Perennial Crops (growing media, type and size of containers, etc):	<p>Spores can be germinated on nutrient agar. To increase prothallus growth rate, add inorganic salts and sucrose (8). Nutrients and 2% agar are first melted and then cooled to 49 C before pouring into a petri dish. Use 270 mesh screen to sow the spores (9, 10).</p> <p>Spores can also be directly sown on top of sterilized moist soil mix 1 inch from the top. A good sample soil mix is 2/3 peat moss and 1/3 perlite. Then cover the pot with a pane of glass or plastic. The air temperature surrounding the pot should be about 18-24 C. When necessary, moisten the soil with distilled water to prevent salt accumulation and damage (11, 12). The pot should be in indirect sunlight (17).</p>
Establishment Phase (from seeding to germination):	The culture (agar and nutrients) is incubated in light at 27 C for 20 days. Spores germinated and produce moss-

	<p>like growth about 1/8 inch thick, composed of many prothallia. In 3-6 months, the archegonium on the underside of the prothallus becomes ready to be fertilized. A small piece of prothallus is first removed with tweezers and transplanted to wider spacing in a new flat of soil mixture. When the prothallia expands to about ½ inch in diameter and produce tiny sporophyte plants with primary leaves and roots, the fern plant is now ready for the second transplant (9, 10, 13).</p> <p>For the moss and perlite medium, when the prothalli appears, transfer them to sterile soilless seed mix. Then the setup should be wrapped in plastic and placed in indirect sunlight until small fronds are visible (17).</p> <p>Or the prothalli can be left in the containers with supplemental liquid fertilizer each month at ¼ of its normal strength. Wait until fronds appear before transplanting (17).</p>
Length of Establishment Phase:	Two to three months if germinated in 2% agar and nutrient medium to reach frond phase (9, 10).
Active Growth Phase (from germination until plants are no longer actively growing):	NA.
Length of Active Growth Phase:	NA.
Hardening Phase (from end of active growth phase to end of growing season; primarily related to the development of cold-hardiness and preparation for winter):	When the fronds are 5-8cm tall, pot the fronds into 5-8 cm tall pots and let them grow in indirect sunlight. It is also important to block wind from the tender transplants (17).
Length of Hardening Phase:	NA
Harvesting, Storage and Shipping (of seedlings):	NA
Length of Storage (of seedlings, between nursery and outplanting):	2-3 years (17).
Guidelines for Outplanting / Performance on Typical Sites (eg, percent survival, height or diameter growth, elapsed time before flowering):	NA
Other Comments (including collection restrictions or guidelines, if available):	Sanitize all equipment (14).

PROPAGATION DETAILS: Vegetatively

Ecotype (this is meant primarily for experimentally derived protocols, and is a description of where the seed that was tested came from):	NA
Propagation Goal (Options: Plants, Cuttings, Seeds, Bulbs, Somatic Embryos, and/or Other Propagules):	Sporophyte
Propagation Method (Options: Seed or Vegetative):	Vegetative
Product Type {options: Container (plug), Bareroot (field grown), Plug + (container-field grown hybrids, and/or Propagules (seeds, cuttings, poles, etc.)}	Container
Stock Type:	rhizomes
Time to Grow (from seeding until plants are ready to be outplanted):	NA
Target Specifications (size or characteristics of target plants to be produced):	NA
Propagule Collection (how, when, etc):	Division is best done in late winter or early spring (15).
Propagule Processing/Propagule Characteristics (including seed density (# per pound), seed longevity, etc):	The rhizomes used for propagation should be thick (14). Each section should be about 5-8 cm long, more than 1 growing points, and a root system (17).
Pre-Planting Propagule Treatments (cleaning, dormancy treatments, etc):	NA
Growing Area Preparation / Annual Practices for Perennial Crops (growing media, type and size of containers, etc):	NA
Establishment Phase (from seeding to germination):	At the end of this phase, the propagules start growing (17).
Length of Establishment Phase:	2-3 months
Active Growth Phase (from germination until plants are no longer actively growing):	NA
Length of Active Growth Phase:	NA
Hardening Phase (from end of active growth phase to end of growing season; primarily related to the development of cold-hardiness and preparation for winter):	NA
Length of Hardening Phase:	NA
Harvesting, Storage and Shipping (of seedlings):	NA

Length of Storage (of seedlings, between nursery and outplanting):	NA
Guidelines for Outplanting / Performance on Typical Sites (eg, percent survival, height or diameter growth, elapsed time before flowering):	NA
Other Comments (including collection restrictions or guidelines, if available):	NA

INFORMATION SOURCES	
References (full citations):	See below.
Other Sources Consulted (but that contained no pertinent information) (full citations):	See below.
Protocol Author (First and last name):	Zhu Zhu Xiao
Date Protocol Created or Updated (MM/DD/YY):	06/03/09

Note: This template was modified by J.D. Bakker from that available at:
<http://www.nativeplantnetwork.org/network/SampleBlankForm.asp>

References:

1. USDA Natural Resource Conservation Service. Plant Profile: *Pentagramma triangularis*. [<http://plants.usda.gov/java/profile?symbol=PETRT>] [May 28, 2009 10:32PM].
2. CalFlora: Information on California plants for education, research and conservation. 2000. The CalFlora Database, Berkley. [http://www.calflora.org/cgi-bin/species_query.cgi?where-calrecnum=6234] [May 28, 2009 11:26PM]
3. The Jepson Manual: Higher Plants of California. Edited by James C. Hickman. 1993. University of California Press.
4. University of Washington Herbarium: *Pentagramma triangularis*. Seattle, Washington. [<http://biology.burke.washington.edu/herbarium/imagecollection.php>] [May 29, 2009 1:35PM]
5. Oregon Plant Atlas. *Pentagramma triangularis*. [<http://cladonia.nacse.org/platlas/jclass/PassTaxonNameViaURL.htm#Pentagramma,triangularis>] [May 29, 2009 1:52PM]

6. Peck, M.E. 1961. A manual of the higher plants of Oregon, 2nd ed. Oregon State University Press, Corvallis.
7. Davis, R. 1952. Flora of Idaho. Brigham Young University Press. Provo, Utah.
8. Khoo, S.I., and M.B. Thomas. 1980. Studies on the germination of fern spores. The plant propagator 26: 11-15.
9. Lane, B.C. 1980. A procedure for propagating ferns from spores using a nutrient-agar solution. Proc. Inter. Plant Prop Soc. 30:94-97.
10. Tjosvold, S., and A. Teasdale. 1980. Uniform fern spore dispersal on warm nutrient-agar solution. The plant propagator 26:11.
11. Robert, D. J. 1965. Modern propagation of ferns. Proc. Inter. Plant Prop. Soc. 15: 317-21.
12. Stokes, P. 1984. Hardy ferns. Proc. Inter. Plant Prop. Soc. 34: 332-33
13. Knauss, J.F. 1976. A partial tissue culture method for pathogen-free propagation of selected fern from spores. Proc. Fla. State Hort Soc 89:363-65
14. Hartmann, H.T., D.E. Kester, F.T. Davis Jr., and R.L. Geneve. 2002. Hartmann and Kester's plant propagation: principles and practices. Prentice Hall, Upper Saddle river, NJ.
15. Robson, K., Richter, A., and Filbert, M. 2008. Encyclopedia or Northwest Native Plants for Gardens. Timber Press.
16. Flora of North America. *Pentagramma triangularis*. [http://www.efloras.org/object_page.aspx?object_id=41251&flora_id=1] [Access June 3, 2009].
17. Toogood A., editor. 1999. The American Horticultural Society Plant Propagation. New York, NY: DK Publishing, Inc. P159-163.
18. Henny, R. J., Knauss, J.F., and Donnan Jr. A. 1981. Foliage plant tissue culture. In Foliage plant production, J. Joiner, ed. Englewood Cliffs, NJ: Prentice Hall.
19. Foster, F.G. 1984. Ferns to Know and Grow. Portland, OR: Timber Press.
20. Las Pilitas Nursery. [<http://www.laspilitas.com/nature-of-california/plants/pityrogramma-triangularis>] [Access May 30, 2009 4:47PM].

Not Useful References:

Consortium of California Herberia. [http://ucjeps.berkeley.edu/cgi-bin/get_consort.pl] [Access May 29, 2009 2:07PM].

Detailed records and map of PETRT distribution in California.

Douglas County Museum of Natural & Cultural History. Oregon.

[<http://www.co.douglas.or.us/museum/default.asp>] [Access May 29, 2009 2:06PM].

Kaye T., Maxwell, C. Plant Life of Washington State: Dungeness Spit, Willapa Hills, and Lower Columbia River. Washington Native Plant Society. Volume 4, 1991.

Marion Ownbey Herbarium. Washington State University. [<http://www.wsu.edu:8080/~wsherb/>] [Accessed May 29, 2009 2:04PM].

Native Plants Propagation Protocol Database.

[<http://nativeplants.for.uidaho.edu/network/search.asp?SearchType=Continental>] [May 29, 2009 2:00PM].

University of Idaho Stillinger Herbarium.

[<http://www.sci.uidaho.edu/biosci/herbarium/index.html>] [Access May 29, 2009 2:10PM].

Washington Flora Checklist. *Pentagramma triangularis* (Kaulf.) Yatsk., Windham & E.

Wollenw. ssp. *triangularis*.

[<http://biology.burke.washington.edu/herbarium/waflora/checklist.php?Taxon=Pentagramma%20triangularis%20ssp.%20triangularis>] [May 29, 2009 1:45PM].

Weinmann, F., Zika P.F., Giblin D.E., and Legler B. 2002. Checklist of the Vascular Plants of Washington State. University of Washington Herbarium.

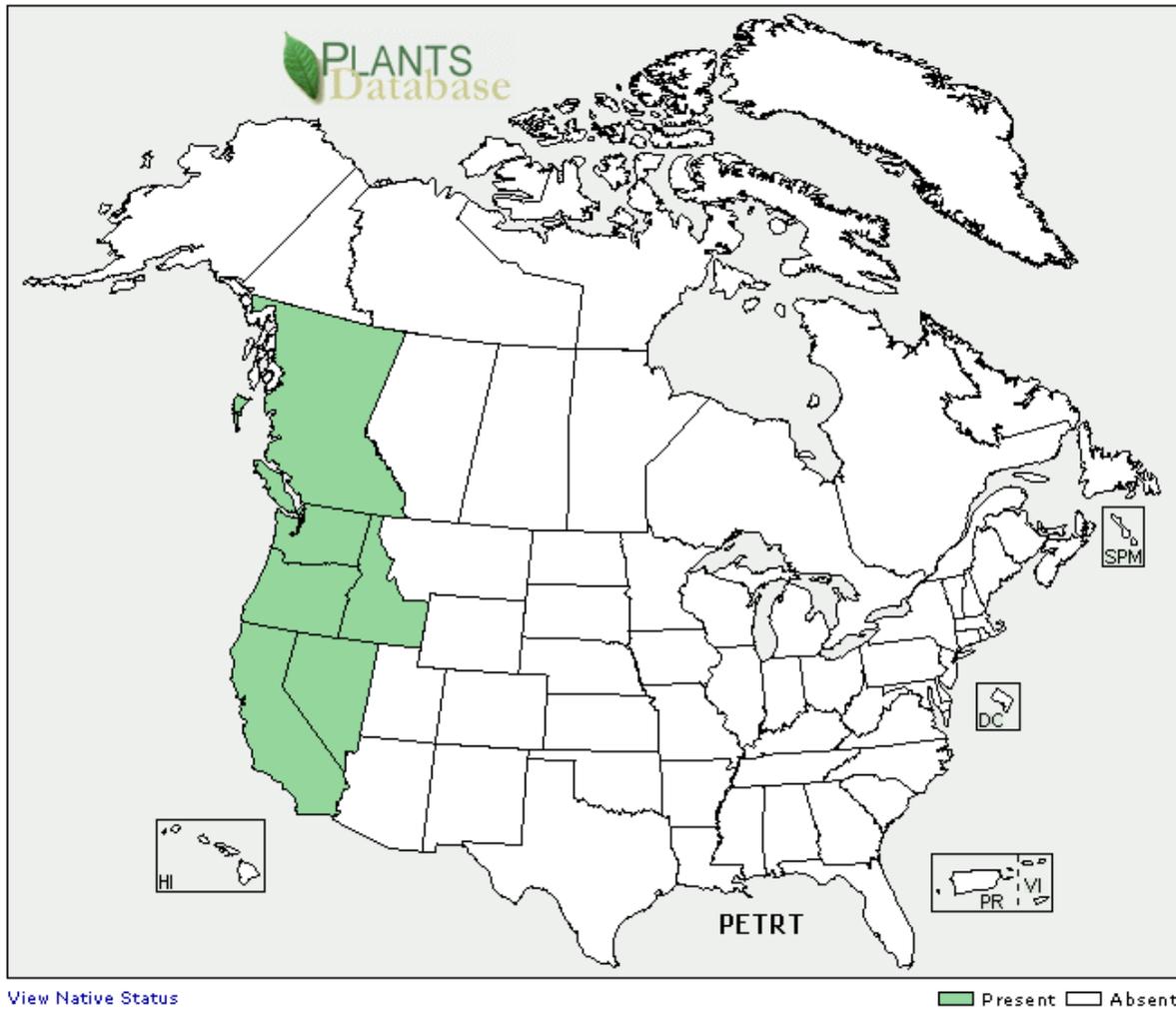
[<http://biology.burke.washington.edu/herbarium/waflora/checklist.php>] [Accessed May 29 2009 1:30PM].

Appendix

Fig. 1

Distribution:

Pentagramma triangularis (Kaulf.) Yatsk., Windham & E. Wollenw. ssp. *triangularis*



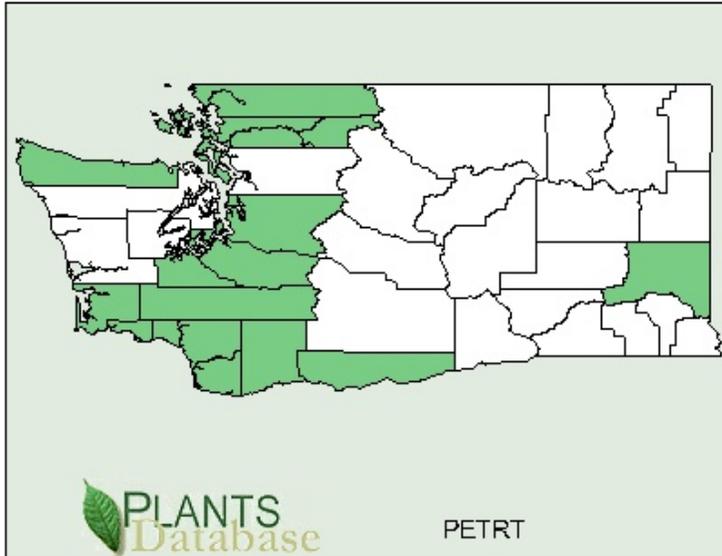
The data are based primarily on the literature, herbarium specimens, and confirmed observations. Only native and naturalized populations are mapped.

USDA Natural Resource Conservation Service. Plant Profile: *Pentagramma triangularis*. [<http://plants.usda.gov/java/profile?symbol=PETRT>] [May 28, 2009 10:32PM].

Appendix continued...

Fig. 2

Pentagramma triangularis (Kaulf.) Yatsk., Windham & E. Wollenw. ssp. *triangularis* - goldback fern
PETRT
in the state of Washington



The data are based primarily on the literature, herbarium specimens, and confirmed observations. Only native and naturalized populations are mapped.

USDA Natural Resource Conservation Service. Plant Profile: *Pentagramma triangularis*.
[<http://plants.usda.gov/java/profile?symbol=PETRT>] [May 28, 2009 10:34PM].

Appendix continued...

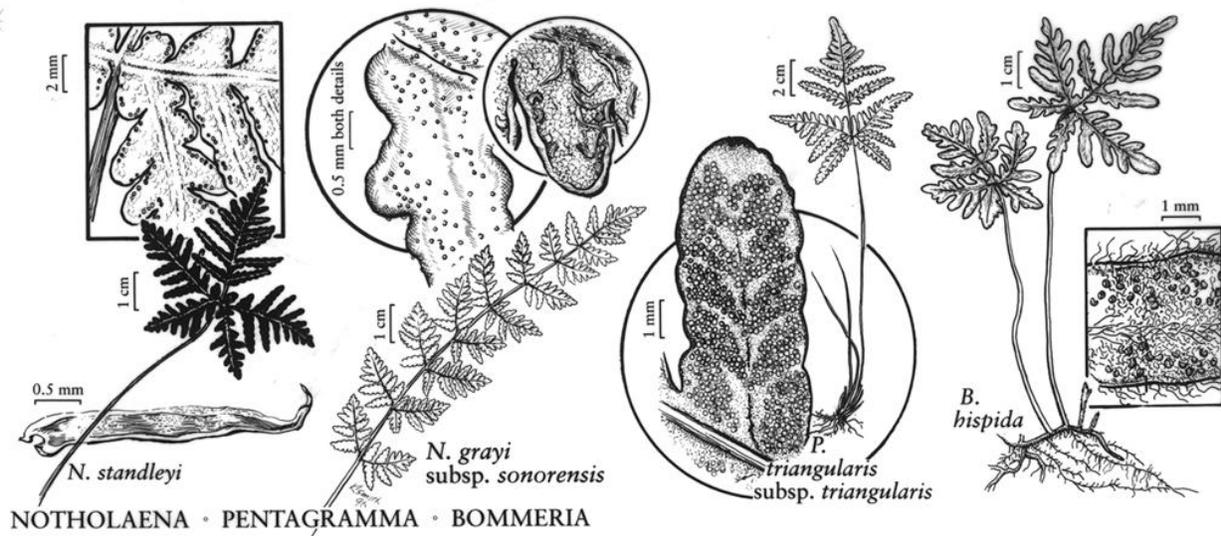
Fig. 3



Photographer: Jim Riley. Courtesy of Burke Museum of Natural History and Culture and University of Washington Herbarium.
[<http://biology.burke.washington.edu/herbarium/imagecollection/imagelarge.php?ImageNumber=5574&TaxonID=3636&SourcePage=taxon&>]

Appendix continued...

Fig. 4



Flora of North America. *Pentagramma triangularis*.

[http://www.efloras.org/object_page.aspx?object_id=41251&flora_id=1] [Access June 3, 2009].