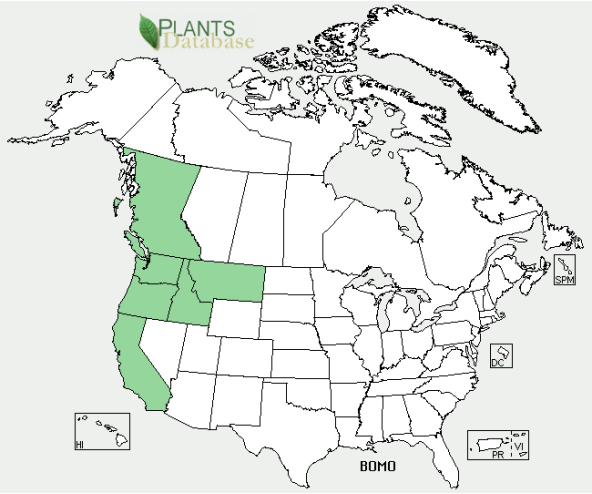
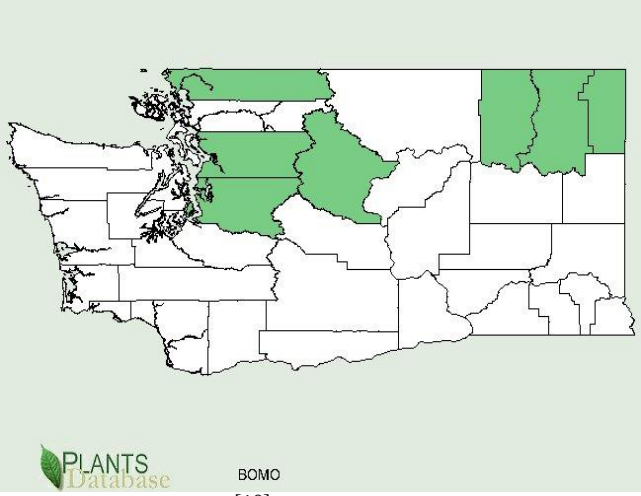
Plant Propagation Protocol for *Botrychium montanum*
ESRM 412 – Native Plant Production
Protocol URL: https://courses.washington.edu/esrm412/protocols/BOMO.*pdf*





Images from USDA Plants Database[10]

TAXONOMY	
Plant Family	
Scientific Name	Ophioglossaceae [10].
Common Name	Adder's-tongue [10].
Species Scientific Name	
Scientific Name	*Botrychium montanum* W.H. Wagner [10].
Varieties	None
Sub-species	None
Cultivar	None
Common Synonym(s)	None
Common Name(s)	Mountain moonwort [10], Western goblin [9], Grape ferns [7].
Species Code (as per USDA Plants database)	BOMO [10].
GENERAL INFORMATION	
Geographical range	USA (CA, ID, MT, OR, WA), CAN (BC) [10]. *See Distribution Maps
Ecological distribution	Narrow range of distribution in old growth forests [9]. Rare occurrence, only 1 per 100 plants surveyed in its native habitat. NatureServe global ranking of "Vulnerable to extirpation or extinction" [1].
Climate and elevation range	Occurs in moist conditions where soils are moist to wet. Forest understory with a great deal of shade and shelter. Deciduous and will die back to a perennial root system each year [6]. Must be protected from the wind [4].

Local habitat and abundance	Grows almost exclusively at the base of old growth cedar (*Thuja plicata* primarily [1], *Calocedrus decurrens* in California). Also may grow in fens, seeps and meadows along streams with moist, saturated substrate [9].
Plant strategy type / successional stage	Late successional/old growth [9]. Highly dependent on mycorrhizae in its native ecosystem [7].
Plant characteristics	4-12.5 cm tall, herbaceous stalk with a single lobed, irregularly-toothed leaf. Grey/green in color, and dependent on mycorrhizal fungi to survive [7]. Clustered sporangia at the uppermost portion of the plant stalk [3]. Bunched, dense gametophytes (More than 700 per m^2) and high spore density in the soil [5].
PROPAGATION DETAILS From Spore	
Ecotype	N/A
Propagation Goal	Plants
Propagation Method	Spore
Product Type	Plant
Stock Type	N/A
Time to Grow	Will take as long as 8 years to produce a plant [7].
Target Specifications	A plant that is alive.
Propagule Collection Instructions	Use sterile plastic containers when spores are mature and ready to drop in summer [2, 7]. Heat spores with a lamp and tap sporangia to release onto paper for collection [7].
Propagule Processing/Propagule Characteristics	Separate from chaff by tilting collection paper and tapping slightly, chaff will fall away leaving clean spores. Place into sterile container [7].
Pre-Planting Propagule Treatments	None
Growing Area Preparation / Annual Practices for Perennial Crops	Plant in a shaded habitat likely to contain mycorrhizae, shady and moist [2].
Establishment Phase Details	New growth occurs in early spring [7].
Length of Establishment Phase	May take as long as 8 years to produce a plant [7].
Active Growth Phase	A single leaf will be produced which may lack a stalk in early-mid spring [3].
Length of Active Growth Phase	Four months (early/mid spring – early/mid-summer) [3].
Hardening Phase	N/A.
Length of Hardening Phase	N/A.
Harvesting, Storage and Shipping	Collect in the summer months [2], spores can be sown when fresh (within 3 weeks), and may be refrigerated to prolong viability [7].
Length of Storage	Refrigeration might extend viability for a short time, but fresh seeds are more likely to be viable [7].
Guidelines for Outplanting / Performance on Typical Sites	Poor transplants, less than 20% chance of survival, probably impossible to germinate without mycorrhizae

	present [3,].
Other Comments	No successful germination from this method with *B. montanum* has been recorded in any of the cited literature. Sources suggest that the slow growing plant cannot survive or even germinate without mycorrhizae present in nature. Methods suggested are cited from other fern propagation, and suggestions for methods from the cited literature.
PROPAGATION DETAILS From Transplant	
Ecotype	N/A
Propagation Goal	Plants
Propagation Method	Transplant.
Product Type	Live adult plant.
Stock Type	N/A
Time to Grow	Must be fully grown at time of transplant, and have established mycorrhizae [3].
Target Specifications	4-12.5cm tall, alive [2, 9].
Propagule Collection Instructions	Take special care not to disturb the root system/fungal colony. Cut around the specimen with a spade about $0.3m^2$, undercutting to 15cm of soil depth to capture all roots [2].
Propagule Processing/Propagule Characteristics	N/A
Pre-Planting Propagule Treatments	N/A
Growing Area Preparation / Annual Practices for Perennial Crops	As close to the original environment as possible, high shade, moisture, and cedar mulch [2, 9].
Establishment Phase Details	N/A
Length of Establishment Phase	N/A
Active Growth Phase	A single leaf will be produced which may lack a stalk in early-mid spring [3].
Length of Active Growth Phase	Four months (early/mid spring – early/mid summer) [3].
Hardening Phase	N/A
Length of Hardening Phase	N/A
Harvesting, Storage and Shipping	Treat with extreme care and place in as close to a similar environment as possible [2].
Length of Storage	Chances of the plant living beyond 3 years is less than 20% [2].
Guidelines for Outplanting / Performance on Typical Sites	Poor performance outside of natural environment, due to mycorrhizae association and sensitivity to pathogens and environmental disturbance [2, 7].
Other Comments	*B. montanum* is rare or threatened in almost all regions where monitoring is taking place [1]. This method should not be attempted unless a rescue is warranted for population survival, as the mortality rate is higher than 80% [2].

	Sue Olsen describes methods of cultivating other varieties of ferns through side crowns formed by erect rhizomes [8]. It is unlikely this method would be successful with *B. montanum*, as it normally reproduces through spores, although it does have small rhizomes [3], and might be worth attempting.
INFORMATION SOURCES	
References	See Below
Other Sources Consulted	Webster EB. 1918. The Ferns of the Olympics: A popular Treatise on the Ferns of the Olympic Peninsula in Washington State. Smith & Webster, Inc. Port Angeles WA, USA. Slater JR, Jensen HM, Moon WE. 1965. Distribution of Ferns on Some Islands of Washington State. Department of Biology, University of Puget Sound. Tacoma WA, USA.
Protocol Author	Andy Shuckhart
Date Protocol Created or Updated	05/21/14

References

[1] Ahlenslager K, Potash L. 2007. Conservation Assessment for 13 Species of Moonworts (*Botrychium* Swartz Subgenus *Botrychium*). USDA Forest Service Region 6 and USDI Bureau of Land Management, Oregon and Washington. [Internet]. [cited 20 May 2014]. Available from http://www.blm.gov/or/plans/surveyandmanage/files/ca-va-botrychium-13-species-2007-04-18.pdf

[2] Cullina W. 2008. Native Ferns, Moss & Grasses: From Emerald Carpet to Amber Wave: Serene and Sensuous Plants for the Garden. Houghton Mifflin Company. New York NY. pp 42-43, 209.

[3] Frye TC. 1934. Ferns of the Northwest: Covering Washington, Oregon, Idaho, British Columbia, Montana, Wyoming, Central and Northern California. Metropolitan Press. Portland OR, USA. pp 61-71.

[4] Hoshizaki BJ, Moran RC. 2001. Fern Grower's Manual: Revised and Expanded Edition. Timber Press, Inc. Portland OR, USA. pp 226-228.

[5] Johnson-Groh C, Riedel C, Schoessler L, Skogen K. 2002. Belowground Distribution and Abundance of *Botrychium* Gametophytes and Juvenile Sporophytes. Amer. Fern Journ. 92(2):80-92

[6] Jones DL. 1987. Encyclopedia of Ferns. Lothian Publishing Company Pty. Ltd. Port Melbourne, Australia. pp 121, 150, 344.

[7] Olsen S(a). 2007. Encyclopedia of Garden Ferns. Timber Press, Inc. Portland OR, USA. pp 63-75, 158-160.

[8] Olsen S(b). 1998. Hardy Fern Foundation Newsletter Vol 8, Number 2: Special Publication on Propagation. The Hardy Fern Foundation. Medina WA, USA. pp 20-21, 26-31.

[9] US Forest Service. 2005. Appendix 12: Botrychium montanum (Farrar2005). USDA, United States Forest Service. [Internet]. [cited 20 May 2014]. Available from: http://www.fs.fed.us/r6/sfpnw/issssp/documents/planning-docs/ca-va-app12-b-montanum-2005-01-12.doc

[10] USDA Plants Database. 2014. Botrychium montanum. United States Department of Agriculture. [Internet]. [cited 20 May 2014]. Available from: https://plants.usda.gov/core/profile?symbol=BOMO

Botrychium montanum:

Credit: US Forest Service. 2005. Appendix 12: Botrychium montanum (Farrar2005).