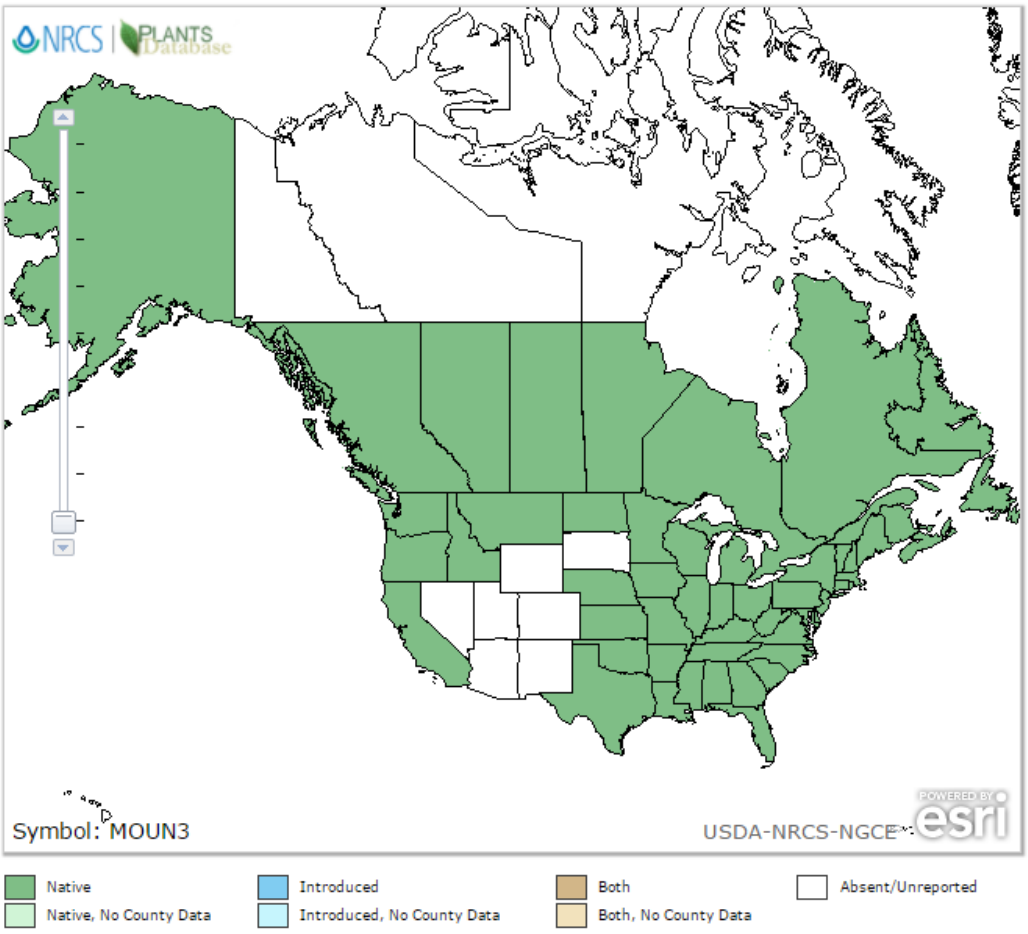
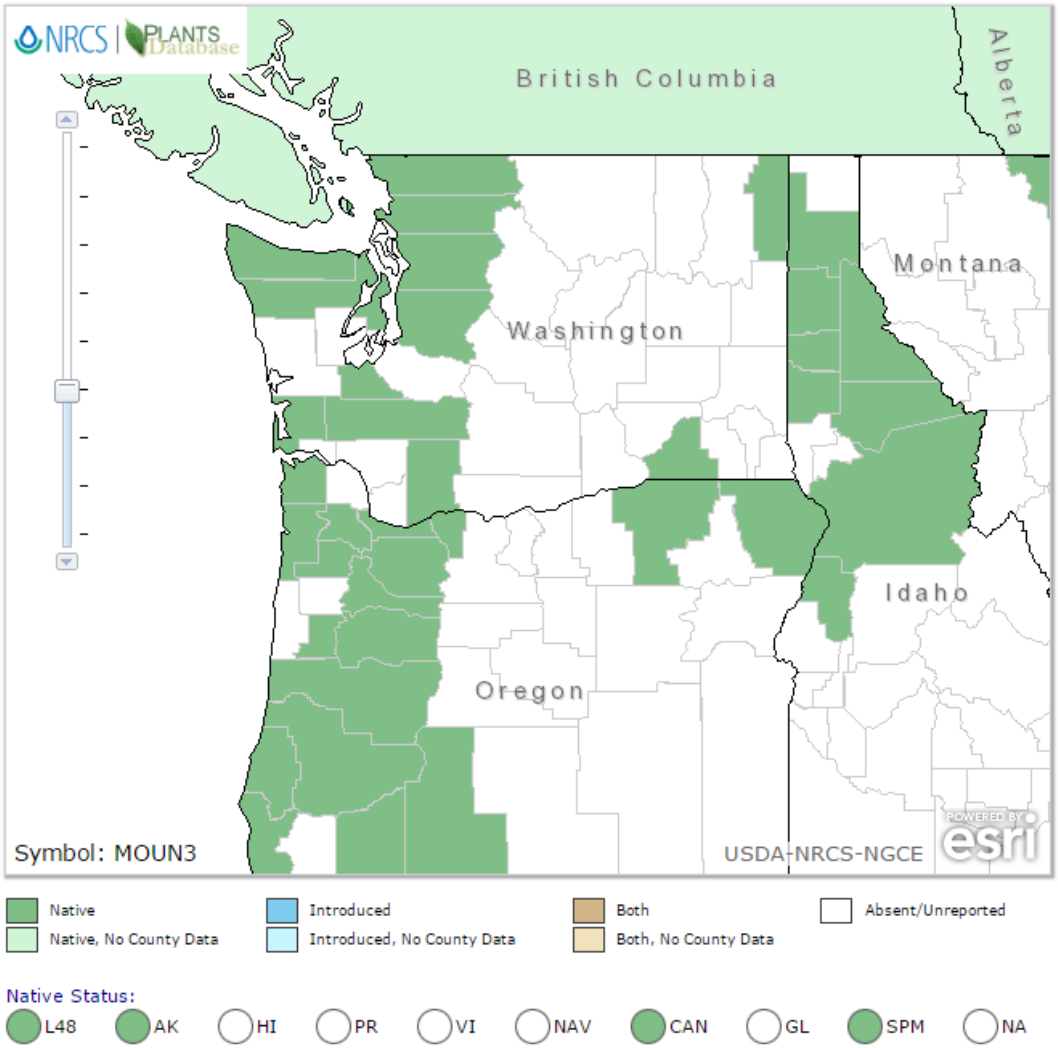
Plant Propagation Protocol for *Monotropa uniflora*
ESRM 412 – Native Plant Production
Protocol URL:https://courses.washington.edu/esrm412/protocols/*MOUN3.pdf*

(Illinois Wildflower)

TAXONOMY	
Plant Family	
Scientific Name	Monotropeaceae (Formerly Ericaceae)
Common Name	Indian Pipe Family (Formerly Heath family)
Species Scientific Name	
Scientific Name	*Monotropa uniflora* L.
Varieties	*Monotropa uniflora* L., var. *typica* (Domin) *Monotropa uniflora* L., var. *coccinea* (Zucarini) *Monotropa uniflora* var. *australis* (Domin) (Atlas of Florida Plants)
Sub-species	
Cultivar	
Common Synonym(s)	*Hypopitys uniflora* (Linnaeus) *Monotopa brittonii* (Small) *Monotropa coccinea* (Zuccarini) *Monotropa coccinea* Z., var. *mexicana* (Lange) *Monotropa coccinea* Z., var. *nicaraguensis* (Lange) *Monotropa humilis* (Don) *Monotropa morisoniana* (Michaux) *Monotropa morisonii* (Persoon) *Monotropa uniflora* (Linnaeus) *forma rosea* (Fosberg) (Atlas of Florida Plants)
Common Name(s)	Ghost plant, ghost flower, ice plant, corpse plant (Pojar, 2004)

Species Code (as per USDA Plants database)	MOUN3
GENERAL INFORMATION	
Geographical range	North America, Central America, Eastern Asia (Neyland & Hennigan, 2004). Critically imperiled in Alaska (Nova Scotia Wild Flora Society). North American Distribution 

	Pacific Northwest Distribution 
Ecological distribution	Occurs at low elevations in the humus of shaded, mature, coniferous forests (Pojar, 2004).
Climate and elevation range	Altitude up to 3000 meters (Bebeau, 2015).
Local habitat and abundance	In the Pacific Northwest, often grows in forests where *Pseudotsuga menziesii* is dominant and is an indicator of wood mushrooms. (Pojar, 2004). Associated with *Fagus* in Florida (Serene, 2000 & Carns, 2004).
Plant strategy type / successional stage	*M. uniflora* is achlorophyllous and therefore is unable to photosynthesize. *M. uniflora* is a mycoheterotrophic perennial and utilizes mycorrhizal associations to obtain nutrients (Bidartondo & Bruns, 2001).
Plant characteristics	Perennial. Insect pollinated. Seeds have membranous wing for wind dispersal (Bebeau, 2015; Serene, 2000 & Carns, 2004).
PROPAGATION DETAILS	
Ecotype	
Propagation Goal	Plants
Propagation Method	Seed
Product Type	Propagules
Stock Type	

Time to Grow	No data found
Target Specifications	5-25 cm (Pojar, 2004)
Propagule Collection Instructions	Flowers between May – October. Young flowers nod facing the ground and become erect when pollinated. (Serene, 2000 & Carns, 2004) Allow capsule to dry on plant. Harvest seeds by breaking open mature capsules. Produces dust-like seeds (Johansson et al., 2017)
Propagule Processing/Propagule Characteristics	100 seeds per capsule (Bebeau, 2015).
Pre-Planting Propagule Treatments	Seeds should be sieved to remove debris (Bidartondo, 2005).
Growing Area Preparation / Annual Practices for Perennial Crops	Monotropoideae germination is triggered by cues produced by closely related fungi. Development slows or is stopped if seeds germinate in response to the wrong fungi. Typically associated with ectomycorrhizal species of *Russula* (Kong et al., 2015). Abundant woodland humus and the presence of appropriate fungi are required for survival. *M. uniflora* has delicate root systems that resist transplanting (Illinois Wildflowers).
Establishment Phase Details	No data found
Length of Establishment Phase	No data found
Active Growth Phase	No data found
Length of Active Growth Phase	No data found
Hardening Phase	No data found
Length of Hardening Phase	No data found
Harvesting, Storage and Shipping	No data found
Length of Storage	Seeds can be stored up to two months (Bidartondo, 2005). In a natural context, seeds can remain viable for several years (Johansson et al., 2017).
Guidelines for Outplanting / Performance on Typical Sites	Cultivating Indian Pipe is very difficult, if not impossible; plants that are transplanted from the wild are highly unlikely to survive (Illinois Wildflowers). Height: Stems 5-25cm tall (Pojar, 2004) Light requirements: sun, part shade, shade (LBJ Wildflower Center). Does not photosynthesize, so can tolerate shade (Illinois Wildflowers). pH requirements: 5.1 to 5.5 (strongly acidic) 5.6 to 6.0 (acidic) 6.1 to 6.5 (mildly acidic)
Other Comments	

INFORMATION SOURCES	
References	Atlas of Florida Plants. (2017). "*Monotropa uniflora*." University of Florida – Institute for Systematic Biology. Modified 26 Apr 2017. Web. 26 Apr 2017. Available at: http://www.florida.plantatlas.usf.edu/Plant.aspx?id=3568 Bebeau, G. D. (2015). Indian Pipe. The Friends of the Wild Flower Garden, Inc. Plants of the Eloise Butler Wildflower Garden. Web. 26 Apr 2017. Available at: http://www.friendsofthewildflowergarden.org/pages/plants/indianpipe.html Bidartondo, M. I. & T.D. Bruns. (2001). Extreme specificity in epiparasitic Monotropoideae (Ericaceae): widespread phylogenic and geographical structure. Molecular Ecology 10(9): 2285-2295. Bidartondo, M. I. & Bruns, T. D. (2005). On the origins of extreme mycorrhizal specificity in the Monotropoideae (Ericaceae): performance trade-offs during seed germination and seedling development. Molecular Ecology, 14: 1549-1560. BSA Parasitic Plant Pages. "*Monotropa uniflora*." Botanical Society of America. N.d. Web. 26 Apr 2017. Available at: http://botany.org/Parasitic_Plants/Monotropa_uniflora.php "Indian Pipe." Illinois Wildflowers. N.d. Web. 26 Apr 2017. Available at: http://www.illinoiswildflowers.info/woodland/plants/indian_pipe.htm Johansson, V.A., M. Bahram, L. Tedersoo, U. Kõljalg, O. Eriksson. (2017). Specificity of fungal associations of *Pyroleae* and *Monotropa hypopitys* during germination and seedling development. Molecular Ecology, 26(9): 2591-2604. Kong, A., J. Cifuentes, A. Estrada-Torres, L. Guzmán-Dávalos, R. Garibay-Orijel, & B. Buyck. (2015). Russulaceae associated with mycoheterotroph *Monotropa uniflora* (Ericaceae) in Tlaxcala, Mexico: a phylogenetic approach. Cryptogamie, Mycologie 36:479–512. Lady Bird Johnson Wildflower Center. "*Monotropa uniflora*." University of Texas at Austin, 3 Apr 2016. Web. 26 Apr. 2017. Available at: http://www.wildflower.org/plants/result.php?id_plant=moun3 "*Monotropa uniflora* (Indian Pipe)." Minnesota Wildflower (2017). Web. 26 Apr 2017. Available at: https://www.minnesotawildflowers.info/flower/indian-pipe Neyland, R., & M. K. Hennigan. (2004). A Cladistic Analysis of *Monotropa uniflora* (Ericaceae) Inferred from Large Ribosomal Subunit (26S) rRNA Gene Sequences. Castanea, 69(4): 265-271. "Monotropaceae: *Monotropa uniflora* L." Nova Scotia Wild Flora Society. 16 Apr 2007. Modified 7 Dec 2008. Web. 26 Apr 2017. Available at: http://www.nswildflora.ca/species/Monotropaceae/MonotUnif/species.html Plants Database: "Plants Profile for *Monotropa uniflora* L. (Indianpipe)." USDA NRCS. N.d. Web. 26 Apr. 2017. Available at: https://plants.usda.gov/core/profile?symbol=moun3

	Pojar J. & A. McKinnon. (2004). Plants of the Pacific Northwest: Washington, Oregon, British Columbia and Alaska, B.C. Ministry of Forests and Lone Publishing, Canada Serene, A. (2000) & C. Carns (2004). Species Page: *Monotropa uniflora*. Pennsylvania State University. 13 Oct 2013. Web. 26 Apr. 2017. Available at: http://www.psu.edu/dept/nkbiology/naturetrail/speciespages/indianpipe.htm Yang, S., & Pfister, D. (2006). *Monotropa uniflora* Plants of Eastern Massachusetts Form Mycorrhizae with a Diversity of Russulacean Fungi. Mycologia, 98(4): 535-540.
Other Sources Consulted	"*Monotropa uniflora* – Ghost Plant, Indian Pipe." USDA Forest Service. N.d. Web. 26 Apr. 2017. Available at: https://www.fs.fed.us/wildflowers/beauty/mycotrophic/monotropa_uniflora.shtml Shelton, M. (2006). "Plant Data Sheet: Indian Pipe (*Monotropa uniflora*). University of Washington. Web. Web. 26 Apr. 2017. Available at: http://depts.washington.edu/propplnt/Plants/monotropa%20uniflora.htm Wallace, G. (1977). Studies of the Monotropoideae (Ericaceae). Floral Nectaries: Anatomy and Function in Pollination Ecology. American Journal of Botany, 64(2), 199-206.
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