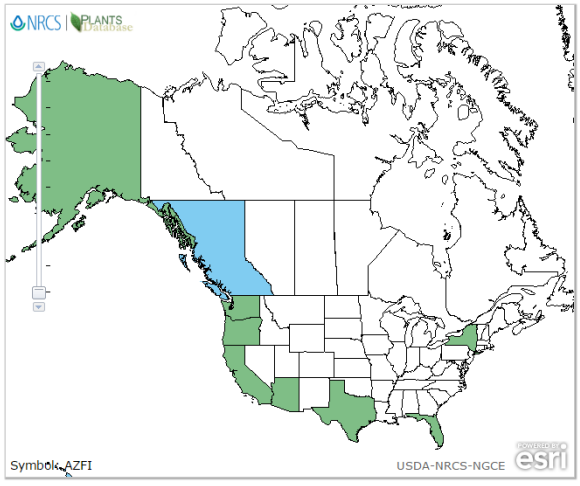
Plant Propagation Protocol for *Azolla filiculoides*
ESRM 412 – Native Plant Production

Protocol URL: https://courses.washington.edu/esrm412/protocols/*AZFI.pdf*

TAXONOMY	
Plant Family	
Scientific Name	Azollaceae
Common Name	Fern Family
Scientific Name	
Species Scientific Name	*Azolla filiculoides* Lam. (12)
Varieties	*Azolla filiculoides* var. *rubra* (R. Brown) Strasburger (4)
Sub-species	None
Cultivar	None
Common Synonym(s)	*Azolla rubra* R. Brown (4)
Common Name(s)	Mosquito Fern (10), Pacific Mosquito Fern (12), Water Fern (3), Ferny Azolla (6)
Species Code (as per USDA Plants Database	AZFI



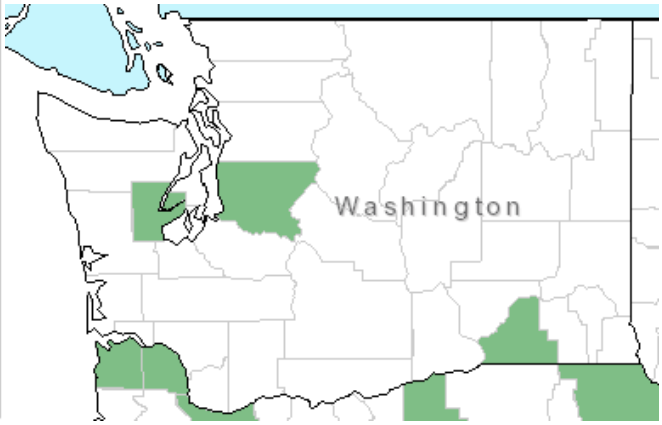


Image 1 (above left): Distribution of *Azolla filiculoides* in North America – Blue Introduced/Green Native - USDA
Image 2 (above right): Distribution of *Azolla filiculoides* in Washington State - USDA

GENERAL INFORMATION	
Geographical Range	Occurs in the Americas, Europe, northeastern Asia, southern Africa, and the Pacific Islands (4) in the USA is found in the states of Alaska, Arizona, California, Florida, New York, Oregon, Texas and Washington (12)
Ecological Distribution	Hardiness Zones 6-7; Grows best in high light, forms dense mats on the water surface. (4) Can also grow on damp ground or mud at the edge of lakes and ponds (3)
Climate and Elevation Range	Can survive under thin layers of ice. (4) Moderately frost tolerant, but best grown in a pond under glass in regions where severe winter frost is common. (3) Plants are not very cold-tolerant, surviving in overwintering by submerged resting buds. (5) Found at low elevations. (2)
Local Habitat and Abundance	Sparse in the region, but can be found at times at the Bellevue Botanical Garden and at times in the Rhododendron Species Botanical Garden in Ocean Shores. (9) In Washington State, it can be found in King, Mason, and Walla Walla Counties. (12)
Plant strategy type / Successional Stage	Mid to Late Successional
Plant Characteristics	Life form: Forb/Herb (12) Leaves occur in pairs, crowded on the stem and are only 1/16 - 1/32" long. (7) Very small in size, largest hairs on the upper leaf lobe are one-celled, and megaspores are warty with raised angular bumps. (4) Free-floating species that can form dense colonies. (6) Has narrower, pointed leaves, and produces separate male and female spores instead of single spores that carry the characteristics of both sexes as most ferns do. (10)

Image 3: *A. filiculoides* - http://www.plantsrescue.com/azolla-filiculoides/
Image 4 (Right): *A. filiculoides* on water: http://www.habitas.org.uk/invasive/species.asp?Item=2090

PROPAGATION DETAILS	
Propagation Goal:	Plants and Spores
Propagation Method	This species propagates freely by vegetative propagation in water. (6) Easily establishes in standing water. (3) Can be propagated by taking a spoonful of spores from an existing specimen and sprinkling in water. (9) In general, aquatic free-floating ferns such as *Azolla* propagate themselves freely by division. (6)
Product Type:	Hydroponics/Aquatic
Stock Type	Hydroponics/Aquatic
Time to Grow	This species can replicate itself in 3 days, although no specifics have been given regarding how large a species can replicate itself to. (9)
Target Specifications	Very small, less than 1/16" (7)
Propagule Collection Instructions	Although this species can propagate itself freely by water as mentioned previously, the best method for human propagule collection is manually collecting spores from healthy specimens. (9)
Propagule Processing/Propagule Characteristics	Unknown
Pre-Planting Propagule Treatments	Unknown
Growing Area Preparation / Annual Practices for Perennial Crops	Grows best in eutrophic ponds with standing water. (2)
Establishment Phase Details	Growth peaks in late spring and slows in winter. (4)
Length of Establishment Phase	Unknown
Active Growth Phase	Unknown
Length of Active Growth Phase	No exact growing phase is specified, however, the perennial can grow to 0.1 meters at a very “fast rate”, however, this source did not divulge what a “fast rate” constitutes, which could be a very different rate for every person. (11)

Hardening Phase	Unknown
Length of Hardening Phase	Unknown
Harvesting, Storage and Shipping	Unknown
Length of Storage	Unknown
Guidelines for Outplanting / Performance on Typical Sites	Unknown
Other Comments	The genus *Azolla* releases nitrogen as it decomposes, which is absorbed by rice, yielding grain rich in proteins, more so than fertilizing with chemicals. (8) This practice is widely used in China and Vietnam as a nitrogen fixation technique. (9) *A. filiculoides* absorbs carbon, and layer upon layers of it have been found on the floor of what was once and inland sea in the Artic, and it has been credited with cooling down the earth millions of years ago. (9) This species prevents mosquito breeding. (10) This species grows in association with the heterocystous cyanobacterium (blue-green algae) Anabaena azollae, which has the ability to fix nitrogen, within the dorsal leaf lobe cavities. (1)

INFORMATION SOURCES	
References	1. “Azolla Filiculoides (water Fern).” *Azolla Filiculoides (water Fern).* Centre for Agricultural and Biosciences International, n.d. Web. 18 May 2016. Available at: http://www.cabi.org/isc/datasheet/8119 2. “Comprehensive Report Association – Azolla (filiculoides, Mexicana) Herbaceous Vegetation.” *Comprehensive Report Association – Azolla (filiculoides, Mexicana) Herbaceous Vegetation*. NatureServe, n.d. Web. 20 May 2016. Available at: http://explorer.natureserve.org/servlet/NatureServe?searchCommunityUid=ELEMENT_GLOBAL.2.688612 3. Grounds, Roger. *Ferns*. London: Pelham, 1974. Print. 4. Hoshizaki, Barbara Joe., and Robbin Craig Moran. *Fern Grower's Manual.* Portland, Or.: Timber, 2001. Print. 5. Huxley, Anthony, Mark Griffiths, and Margot Levy. *The New Royal Horticultural Society Dictionary of Gardening, Volume 1, A-C*. London: Macmillan, 1992. Print. 6. Jones, David L. *Encyclopedia of Ferns: An Introduction to Ferns, Their Structure, Biology, Economic Importance, Cultivation, and Propagation.* Melbourne: Lothian Pub., 1987. Print. 7. Mickel, John. *Ferns for American Gardens*. New York: Macmillan, 1994. Print. 8. Moran, Robbin Craig. *A Natural History of Ferns*. Portland: Timber, 2004. Print. 9. Olsen, Sue. Owner of Foliage Gardens and Author, email communication, 22 MAY 2016. 10. Perl, Philip. *Ferns*. Alexandria, VA: Time-Life, 1977. Print. 11. “Pfaf Plant Search.” *Pfaf Plant Search.* Plants For A Future, n.d. Web. 20 May 2016. Available at: http://www.pfaf.org/user/Plant.aspx?LatinName=Azolla+filiculoides 12. "Plants Profile for Azolla Filiculoides (Pacific Mosquitofern)." *Plants Profile for Azolla Filiculoides (Pacific Mosquitofern).* United States Department of Agriculture, n.d. Web. 20 May 2016. Available at: http://plants.usda.gov/core/profile?symbol=AZFI
Other Sources Consulted	Foster, F. Gordon. *Ferns to Know and Grow*. Portland, Or.: Timber, 1984. Print. Foster, F. Gordon. *The Gardener’s Fern Book; a Guide for the Gardener, a Reference for the Nature-lover*. Princeton, NJ: Van Nostrand, 1964. Print. Frankel, Edward, and Edgar M. Paulton. *Ferns, a Natural History*. Brattleboro, VT: S. Greene, 1989. Print. MacKinnon, A., Jim Pojar, and Paul B. Alaback. *Plants of the Pacific Northwest Coast: Washington, Oregon, British Columbia & Alaska*. Vancouver: Lone Pine Pub., 2004. Print. Pettinger, April. *Native Plants in the Coastal Garden: A Guide for Gardeners in British Columbia and the Pacific Northwest*. Vancouver: Whitecap, 1996. Print. Rose, Robin, Caryn E. C. Chachulski, and Diane L. Haase. *Propagation of Pacific Northwest Native Plants*. Corvallis: Oregon State UP, 1998. Print.
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