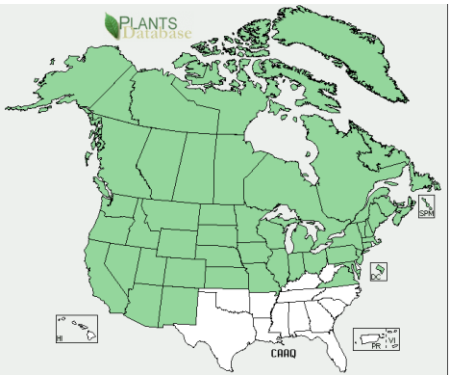
Plant Propagation Protocol for *[Carex aquatilis* Wahlenb*.]*
ESRM 412 – Native Plant Production



TAXONOMY	
Family Names	
Family Scientific Name:	Cyperaceae [1]
Family Common Name:	Sedge family [1]
Scientific Names	
Genus:	*Carex* [1]
Species:	*Aquatilis*[1]
Species Authority:	Wahlenb [1]
Variety:	n/a
Sub-species:	*Carex aquatilis* Wahlenb. ssp. *altior* (Rydb.) Hultén *Carex aquatilis* Wahlenb. ssp. *stans* (Drejer) Hultén [1]
Cultivar:	*Carex aquatilis* Wahlenb. var. *aquatilis* *Carex aquatilis* Wahlenb. var. *altior* (Rydb.) Fernald *Carex aquatilis* Wahlenb. var. *substricta* Kük. *Carex aquatilis* Wahlenb. var. *dives* (T. Holm) Kük. *Carex aquatilis* Wahlenb. var. *sitchensis* (Prescott ex Bong.) L. Kelso *Carex aquatilis* Wahlenb. var. *stans* (Drejer) Boott [1]
Authority for Variety/Sub-species:	(Rydb.) Hultén (Drejer) Hultén [1]
Common Synonym(s) (include full scientific names (e.g., *Elymus glaucus* Buckley), including variety or subspecies information)	***Carex aquatilis* Wahlenb. var. *aquatilis*** -CAAC10 *Carex acutinella* Mack. -CAAQA4 *Carex aquatilis* Wahlenb. ssp. *altior* (Rydb.) Hultén -CAAQA5 *Carex aquatilis* Wahlenb. var. *altior* (Rydb.) Fernald -CAAQS2 *Carex aquatilis* Wahlenb. var. *substricta* Kük.

	-CASU24 *Carex substricta* (Kük.) Mack. -CASU23 *Carex suksdorfii* Kük. ***Carex aquatilis* Wahlenb. var. *dives* (T. Holm) Kük.** -CAAQS4 *Carex aquatilis* Wahlenb. var. *sitchensis* (Prescott ex Bong.) L. Kelso -CAHO14 *Carex howellii* L.H. Bailey -CAPA55 *Carex panda* C.B. Clarke -CASI3 *Carex sitchensis* Prescott ex Bong. ***Carex aquatilis* Wahlenb. var. *stans* (Drejer) Boott** -CAAQS3 *Carex aquatilis* Wahlenb. ssp. *stans* (Drejer) Hultén -CAST39 *Carex stans* Drejer [1]
Common Name(s):	Water sedge [1]
Species Code (as per USDA Plants database):	CAAQ [1]
GENERAL INFORMATION	
Geographical range (distribution maps for North America and Washington state)	Throughout North America with the exception of the southeastern states. See map above. [7]
Ecological distribution (ecosystems it occurs in, etc):	Fens, swamps, marshes, wet meadows, lake-shores from low to middle elevations the length of our region, but it occurs much more common on the east. [7]
Climate and elevation range	Widespread and very common at low elevations, 4-3657 m in wet soil, shallow water or swampy places. [2]
Local habitat and abundance; may include commonly associated species	The water regime best suited for water sedge is one with the water table above ground level in early June and adequate moisture in the root zone throughout the year. Water sedge grows best on flat or concave surfaces with a maximum slope of 10 percent. [8] Water sedge usually grows in Histosol, Inceptisol or Mollisol (cruaquoll) soil. It grows best in cold soils ranging from sandy loam to clay. The soil climate can vary from semiarid to humid. [8]
Plant strategy type / successional stage (stress-tolerator, competitor, weedy/colonizer, seral, late successional)	If established, it will compete well with invaders. It recovers quickly from low intensity fires where the rhizomes are protected by the mineral soil. On post burned sites, it is an opportunistic colonizer. [2]
Plant characteristics (life form (shrub, grass, forb), longevity, key characteristics, etc)	Perennial sedge, long, cord-like rhizomes, lower spikes that are short-stalked or stalkless and erect and scales that are shorter than the perigynia and lacking tips. [7] Leaf: 3-10 mm wild, knot-like crosswalls between the

	veins; sheaths dark tinged at mouth. [7] Inflorescence: long, cylindrical spkes; 1-4 erect, male, terminal spikes; lower 3-5 spikes female or with male flowers at top, erect or drooping on slender stalks; lowermost bract leaf-like, longer than inflorescence [7]
PROPAGATION DETAILS	
Ecotype (this is meant primarily for experimentally derived protocols, and is a description of where the seed that was tested came from):	Rocky Mountains [8]
Propagation Goal (Options: Plants, Cuttings, Seeds, Bulbs, Somatic Embryos, and/or Other Propagules):	Plants [5]
Propagation Method (Options: Seed or Vegetative):	Seeds [5]
Product Type (options: Container (plug), Bareroot (field grown), Plug + (container-field grown hybrids, and/or Propagules (seeds, cuttings, poles, etc.))	Container or plug [5]
Stock Type:	10 cubic inch container [5]
Time to Grow (from seeding until plants are ready to be outplanted):	4 months [5]
Target Specifications (size or characteristics of target plants to be produced):	Healthy root development filling a 10 ci container.[9]
Propagule Collection (how, when, etc):	Seed is most commonly collected by hand. Seed is hard and brown when ripe in July. Wild land seed collection techniques vary greatly and must be tailored to the target species. Seed can be stripped from the inflorescence or shake it off the stem or the inflorescence can be clipped the stem with scissors or small scythes just below the seed head. Harvested seed is stored in paper bags at room temperature until cleaned.[5]
Propagule Processing/Propagule Characteristics (including seed density (# per pound), seed longevity, etc):	Seed is air dried in paper sacks for several weeks prior to processing. [4] Seed can be sow through a film canister to accurately sow small seeds. Measured the size of the species than intend to sow to get an idea of how large and small to make the hole of the canister. [4]

	Small amount of seeds can be cleaned with an air column separator. Larger amount of seeds are threshed with a hammer mill. [9] Seed is then pre-cleaned using an air screen cleaner with a 1.80 mm screen to remove stems and other inert matter. The perigynium is then removed from the seed using a corrugated rubbing board or hammer mill and then re-cleaned with a 1.55 mm screen and light air. [9] Purities of over 95% are typical. There are approximately 450,000 seeds/lb with perigynium still intact, and 900,000 seeds/lb with perigynium removed. Viability depends on seed fill. [4]
Pre-Planting Propagule Treatments (cleaning, dormancy treatments, etc):	Seed is stored in cool dry conditions with temperatures of 10 °C (50 °F) and relative humidity of 20 to 30%. Seed is not stratified prior to planting. [6]
Growing Area Preparation / Annual Practices for Perennial Crops (growing media, type and size of containers, etc):	In spring bring planted seeds into greenhouse. Those seeds in peat sandwiches can be planted either directly outside in wetland bed (coir mat with inch of obligate soil mix) or into cells filled with obligate soil mixture and then placed in greenhouse. [10] Planted into 56 cm x 41 cm (22 in x 16 in) greenhouse trays filled with a 1:1:1 (v:v:v) mix of peat, perlite, and sand. Rows were created using an imprinting jig designed to make eight, 30-cm (12-in) rows, 6 mm (0.25 in) wide and 6 mm (0.25 in) deep. Treatments were placed in a randomized complete block design with 8 replicates. [10] Seeds were then pressed into the soil using the imprinting jig to provide good seed-to-soil contact. Drilled rows were then covered with approximately 6 mm (0.25 in) of soil mix that was lightly pressed into the rows by hand. [10] The greenhouse trays were placed in a 1.2 m x 2.4 m x 0.3 m (4 ft x 8 ft x 1 ft) tank that was used to simulate a natural wetland in the greenhouse. Water was added slowly to the tank allowing the trays to saturate from the bottom up to remove any air pockets in the medium. Water was then allowed to slowly spill over the edges of the greenhouse trays and into the rows. The tank was flooded until the water line was about 1.3

	cm (0.5 in) above the medium surface. [10]
Establishment Phase (from seeding to germination):	Soil is a 1:1:1 mix of perlite, peat and sand. No fertilizer is added to the soil mix. Seed needs to be kept moist with an overhead mist irrigation schedule of 2 minutes/hr from 9:00 am to 5:00 pm for the first 30 days. Day time greenhouse temperatures range from 32 to 43 °C (90 to 110 °F). Night time temperatures average around 30 °C (85 °F). Grow lights are kept on during nighttime hours. [9, 10]
Length of Establishment Phase:	Germination occurs around 5 to 7 days after planting under temperatures and moisture conditions specified. Full stands (90-100%) are reached in 12 days. [3]
Active Growth Phase (from germination until plants are no longer actively growing):	After full establishment, plants are fertilized once per week with Miracle Grow All Purpose Plant Food (15-30-15). After 30 days the irrigation amount is increased to 3 minutes/hr from 9:00 am to 5:00 pm and grow lights are turned off. Greenhouse day time temperatures are reduced to 30 to 32 ℃ (85 to 90 °F). [3,9]
Length of Active Growth Phase:	3 months [9]
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):	Heat is turned off and temperatures reduced to ambient conditions. Watering is discontinued approximately 3 days prior to delivery. [3 ,9]
Length of Hardening Phase:	1 week [3]
Harvesting, Storage and Shipping (of seedlings):	Seedlings were lifted late September to early October. [3]
Length of Storage (of seedlings, between nursery and outplanting):	No storage [3]
Guidelines for Outplanting / Performance on Typical Sites (eg, percent survival, height or diameter growth, elapsed time before flowering):	Seedlings can be hand-planted or dibbled into moist soil or standing water. The plant will have 100% establishment is typical if ensure good irrigation. [6] Dibbling was required to transplant these deeper-rooted seedlings. We intend to use 70-count trays, 7.6 cm (3 in) deep in future production to eliminate the need for dibbling. The last frost-free date for our location is May 15, but plugs were transplanted into mulch beds when forecasts indicated mild nighttime low temperatures over the next several days. [6] Seedlings were planted the end of September and first of October in a 3 acre constructed wetland. Soils are a sandy loam over a very compacted sandy clay loam. We used an auger with a three inch bit to create holes.

	Seedlings were irrigated with overhead sprinklers several times in the fall. The site was flooded in mid-summer when the seedlings were at least 1.5 feet tall. Some seedlings that were not this tall when flooded died. Seedlings were planted at a density of 25 plants per 100 square feet. [6,9]
Other Comments (including collection restrictions or guidelines, if available):	Controlling water levels and flows is probably the most important factor in direct seeding of wetlands. A single flooding event followed by saturated soil conditions may not be representative of natural conditions encountered when seeding a wetland. Multiple flooding events and stronger flows certainly have the potential to wash away or bury more seeds. Long periods of high water levels can also reduce seed-to-soil contact, dissolve tackifier, or degrade Submerseed clays and polymers, all of which would release more seeds into the water. [6, 10] Stone Nursery, 3 acres constructed wetland. Soils are a sandy loam over a very compacted sandy clay loam. An auger with a three inch bit was used to create holes. Seedlings were irrigated with overhead sprinklers several times in the fall. The site will not be flooded until the seedlings reach a height of at least 2.5 feet high. This will be in the late spring to early summer. The maximum water depth in the constructed wetland is 1.5 feet. Seedlings were planted at a density of 25 plants per 100 square feet. [6, 9, 10]
INFORMATION SOURCES	
References (full citations):	See below
Other Sources Consulted (but that contained no pertinent information) (full citations):	
Protocol Author (First and last name):	Xincai Cai
Date Protocol Created or Updated (MM/DD/YY):	5/16/2012

[1]*Plant Database* . (2012, May 10). Retrieved May 13, 2012, from USDA : http://plants.usda.gov/java/profile?symbol=CAAQ

[2]*Range Plants of Utah* . (2012, January 15). Retrieved May 13, 2012, from Utah State Univeristy Cooperative Extension : http://extension.usu.edu/rangeplants/htm/water-sedge

[3]Boyer, L. (2008). Providing Native Plant Diversity to the Willamette Valley Ecoregio: No-tech, low-tech, and old-tech seed production methods . *Native Plant*, 12.

[4]Dawn, T. (2004). Low Cost Tools for Seed Collection and Seed sowing . *Native Plants*, 3.

[5]Erickson, V. J. (2008). Developing Native Plant Germplasm for National Forests and Graasslands in the Pacific Northwest . *Native Plants*, 13.
[6]Houseal, G. (2010). Plasticulture for Seed Production of Wetland (Carex) Species . *Native Plants* , 8.
[7]Mackinnon, P. (2004). *Plants of The Pacific Nothwest Coast.* Vancourver : Ministory of Forests and Lone Pine .
[8]Management, O. R. (2005). *Water Sedge* . Vancourver .
[9]Tilley, D. (2010, May 7). *Propagation Procotol Database* . Retrieved May 13, 2012, from Native Plant Network : http://www.nativeplantnetwork.org/Network/ViewProtocols.aspx?ProtocolID=3864
[10]Tilley, D. J. (2006). Comparison of Methods for Seeding Nebraska sedge and Baltic rush . *Native Plants* , 6.