Plant Assessment Form

For use with the "Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands" by the California Exotic Pest Plant Council and the Southwest Vegetation Management Association (Warner et al. 2003)

Printable version, February 28, 2003
(Modified for use in Arizona, 07/02/04)

Table 1. Species and Evaluator Information

Species name (Latin binomial)**:**	*Hydrilla verticillata* (L.f.) Royle (USDA 2005)
Synonyms:	None identified in USDA (2005)
Common names:	Hydrilla, water thyme, Florida elodea
Evaluation date (mm/dd/yy)**:**	03/26/04
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Committee review date:	03/26/04 and 05/21/04
List date:	05/21/04
Re-evaluation date(s):	

Table 2. Scores, Designations, and Documentation Levels

Question		Score	Documentation Level	Section Scores	Overall Score & Designations
1.1	Impact on abiotic ecosystem processes	**A**	Other published material	**"Impact"** **Section 1 Score:** **A**	**"Plant Score"** **Overall Score:** **Evaluated but not listed** **Alert Status:** **None**
1.2	Impact on plant community	**A**	Other published material		
1.3	Impact on higher trophic levels	**B**	Other published material		
1.4	Impact on genetic integrity	**D**	Other published material		
2.1	Role of anthropogenic and natural disturbance	**A**	Other published material	**"Invasiveness"** *For questions at left, an A gets 3 points, a B gets 2, a C gets 1, and a D or U gets=0. Sum total of all points for Q2.1-2.7:* **11 pts** **Section 2 Score:** **B**	
2.2	Local rate of spread with no management	**U**	No information		
2.3	Recent trend in total area infested within state	**C**	Observational		
2.4	Innate reproductive potential	**A**	Other published material		
2.5	Potential for human-caused dispersal	**C**	Other published material		
2.6	Potential for natural long-distance dispersal	**C**	Other published material		
2.7	Other regions invaded	**B**	Other published material		
3.1	Ecological amplitude	**U**	Observational	**"Distribution"** **Section 3 Score:** **U**	RED FLAG **YES** Something you should know.
3.2	Distribution	**U**	Observational		

Red Flag Annotation

Although based on its question and section scores related to Impact and Invasiveness *Hydrilla verticillata* potentially could have been ranked as a High, Alert taxon, it was assigned an **Evaluated but not listed** designation to reflect its current distribution status: present in the state but only in human-constructed water bodies. If inadvertently introduced into natural, low-elevation water bodies in Arizona, *H. verticillata* easily could establish and flourish in Arizona's wildlands.

Table 3. Documentation

Question 1.1 Impact on abiotic ecosystem processes *Score:* **A** *Doc'n Level:* **Other pub.**
Identify ecosystem processes impacted: *Hydrilla verticillata* restricts water flow in streams, increases sediment and organic matter deposition, reduces availability of light to submerged plants and animals, and alters water quality.
Rationale: No populations are known to be established in Arizona's natural waters. No impacts on Arizona's natural fresh water habitats have been documented; however, research in other areas has documented definite impacts. First, hydrilla colonies fill water columns of streams with dense, tangled mats that physically impede (slow) water flow and increases sedimentation (Godfrey 2000). Second, as vertical hydrilla stems grow from the mud/sediment toward the water surface, shoots branch laterally and create a dense vegetative layer within the top 0.5 m of water column. These dense mats severely reduce sunlight penetration below 1.0 m (Langeland 1996). Third, because hydrilla's photosynthetic system can function at low light intensities (<1% of sunlight), this species can colonize deeper areas of water bodies (9 to 15 meters) than most aquatic macrophytes. As a result, this species can occupy portions of aquatic habitats that have no native submerged plant life (Batcher Undated). Fourth, in situations where hydrilla is the predominate macrophyte biomass, pH is raised, dissolved oxygen concentrations decrease, and water temperature increases (Invasive Plant Atlas of New England Undated).
Sources of information: See cited literature. Also considered information from the Invasive Plant Atlas of New England. Undated. *Hydrilla verticillata* (available online at: http://webapps.lib.uconn.edu/ipane/browsing.cfm?descriptionid=22; accessed March 2004).

Question 1.2 Impact on plant community composition, structure, and interactions *Score:* **A** *Doc'n Level:* **Other pub.**
Identify type of impact or alteration: *Hydrilla verticillata* displaces native species and reduces native seed production. In addition, biomass production is reduced by hydrilla, as it excludes light from native plants.
Rationale: No *H. verticillata* populations have been reported in natural aquatic habitats in Arizona, but this species' detrimental effects in natural areas of the southeastern U.S. indicate it poses a direct threat to Arizona lakes and streams. Hydrilla has been shown to have the capability to replace native species of *Potamogeton* and *Vallisneria* in the southeastern U.S. (Haller and Sutton 1975, Spencer and Ksander 2000). Colonies of hydrilla have been shown to reduce seed banks of native species in lake sediments de Winton and Clayton 1996)**.** Hydrilla's mat-forming ability at water surfaces intercept (block) light to other submerged plants (Batcher Undated)..
Sources of information: See cited literature.

Question 1.3 Impact on higher trophic levels *Score:* **B** *Doc'n Level:* **Other pub.**
Identify type of impact or alteration: *Hydrilla verticillata* increases mosquito habitat, provides substrate for epiphytic cyanobacteria (bluegreen algae) that produce neurotoxins that are lethal to waterfowl, and provides non-native forage for water fowl. In addition, dense infestations are detrimental to fish habitat.
Rationale: Streams clogged with dense hydrilla populations stagnate to the point that mosquito larvae survive in previously unsuitable habitat. These increases in mosquito habitat become potential breeding sites for vectors of arthropod borne diseases such as West Nile virus, malaria and encephalitis (Invasive Plant Atlas of New England Undated). Largemouth bass populations are adversely affected when hydrilla coverage exceeds 30% (Colle and Sherman 1980). Waterfowl in the southeastern U.S. feeding on hydrilla during November 2001–2003 died of avian vacuolar myelinopathy (AVM; Thomas et al. 1998, Rocke et al. 2002, Fischer et al. 2003). Bald eagles feeding on sick coots also died from the disease. Wildlife pathologists are currently investigating a hypothesis that an undescribed

Stigonematales species is the toxin source. Southeastern U.S. wildlife biologists have detected waterfowl utilizing hydrilla as a forage plant (Johnson and Montalbano 1984, Esler 1989).

The impact on higher trophic levels was given a B and not an A (which was the case for *Myriophyllum spicatum*), because hydrilla is not present in natural areas and in the unnatural areas (golf courses) they are few and often not associated with the wildlife mentioned above.

Sources of information: See cited literature. Also considered information from the Invasive Plant Atlas of New England. *Hydrilla verticillata* (Undated; available online at: http://webapps.lib.uconn.edu/ipane/browsing.cfm?descriptionid=22; accessed March 2004).

Question 1.4 Impact on genetic integrity *Score:* **D** *Doc'n Level:* **Other pub.**

Identify impacts: No known hybridization.

Rationale: No known native congeners in Arizona (Kearney and Peebles 1960).

Sources of information: See cited literature.

Question 2.1 Role of anthropogenic and natural disturbance in establishment *Score:* **A** *Doc'n Level:* **Other pub.**

Describe role of disturbance: Habitat disturbance is not necessary for establishment of this species.

Rationale *Hydrilla verticillata* grows in a wide range of water quality conditions, including oliogotrophic near-pristine habitats (Langeland 1996). Water quality is rarely a limiting factor for establishment (Batcher Undated). Initial establishment of pioneer colonies in an ecosystem requires direct human intervention or waterfowl transport from another ecosystem.

Sources of information: See cited literature.

Question 2.2 Local rate of spread with no management *Score:* **U** *Doc'n Level:* **No info.**

Describe rate of spread: Rate of spread with no management is unknown as current populations (in artificial environments) are managed and contained.

Rationale: No known infestations in natural freshwater habitats in Arizona. Two golf course ponds, one in Phoenix and one in Tucson, are the only presently known infestations in Arizona (Arizona Department of Agriculture 2001–2003). No documentation of dispersal from these sites has been detected during the past 3.5 years. Land owners are applying treatments to keep growth under control.

Sources of information: See Arizona Department of Agriculture, Noxious Weed Distribution Records, 2001–2003. No information on local rate of spread with no management.

Question 2.3 Recent trend in total area infested within state *Score:* **C** *Doc'n Level:* **Obs.**

Describe trend: Stable.

Rationale: No known infestations in natural freshwater habitats in Arizona as of March 2004. Two golf course ponds, one in Phoenix and one in Tucson, are the only presently known infestations in Arizona. No dispersal from these sites has been detected during the past 3.5 years. Land owners are applying treatments to keep growth under control.

Several examples of small populations becoming established in Arizona irrigation canals and backyard ponds since the 1980s are present in Arizona Department of Agriculture, Noxious Weeds files. All of these hydrilla populations were eradicated and no indication exists of hydrilla returning. Likewise, a few retail sales outlets of hydrilla were detected and halted by Arizona Department of Agriculture inspectors during the past 3.5 years.

Sources of information: See Arizona Department of Agriculture, Noxious Weed Distribution Records, 2001–2003. Also considered statewide observations by F. Northam (Weed Biologist, Tempe, Arizona, 2004) while serving as Arizona Noxious Weed Program Coordinator from July 2000 to Dec 2003.

Question 2.4 Innate reproductive potential *Score:* **A** *Doc'n Level:* **Other pub.**
Describe key reproductive characteristics: Rapid vegetative growth; new infestations easily started by small fragments of stem; both turions and tubers are produced asexually; asexual reproduction occurs in Arizona; seed production is possible but seed have a minor impact on dispersal of new infestations; asexual propagule production can be extensive.
Rationale: Field research has documented hydrilla stem growth rate of one inch per day in the southeastern U.S. (Langeland 1996). *Hydrilla verticillata* vegetative growth experiments demonstrated nearly 50% of stems fragments with one whorl of leaves (one node) were able to sprout roots and establish a new plant (Langeland and Sutton 1980). As a result, dispersal of small segments of hydrilla plants can establish new infestations. *Hydrilla verticillata* plants produce vegetative propagules in leaf axils (turions) and on roots (tubers). These asexual structures contain buds that will sprout new plants once they are detached from parent plant and tubers may remain viable and dormant for at least 3-5 years in moist sediment (Godfrey 2000). Field observations by Arizona Department of Agriculture inspectors confirmed hydrilla plants are capable of producing turions and tubers in Arizona (F. Northam, personal observation, 2004). Both monoecious and dioecious biotypes exist in U.S. waters; however, seed production seems to be a minor source of propagule dispersal (Batcher Undated). Asexual propagule densities of 2000 turions and 6000 tubers per sq. meter have been recorded in southeastern U.S. (Batcher Undated).
Sources of information: See cited literature. Also considered statewide observations by F. Northam (Weed Biologist, Tempe, Arizona, 2004) while serving as Arizona Noxious Weed Program Coordinator from July 2000 to Dec 2003.

Question 2.5 Potential for human-caused dispersal *Score:* **C** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Vegetative fragment transport via watercraft and trailers; ornamental plant in aquarium trade and by backyard pond hobbyists; contaminate of other commercially traded aquatic ornamental species including aquarium plants.
Rationale: All authors cited in previous questions acknowledge the threat of new infestation being established by moving hydrilla fragments on boats, boat trailers, bait buckets/boxes, fishing gear, anchors, swamp buggies, etc., and they similarly affirm these human activities are the primary source of extant infestations in the U.S. During the period of July 2000 to December 2003, hydrilla retail sales were stopped and fishpond infestations started from purchased hydrilla plants were abated in Arizona (F. Northam, personal observation, 2004).
Sources of information: See cited literature in previous questions. Also considered statewide observations by F. Northam (Weed Biologist, Tempe, Arizona, 2004) while serving as Arizona Noxious Weed Program Coordinator from July 2000 to Dec 2003.

Question 2.6 Potential for natural long-distance dispersal *Score:* **C** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Downstream movement of stem fragments, turions or tubers; waterfowl transport of stem fragments, turions, or tubers.
Rationale: Once initial human-induced hydrilla populations are established in non-infested regions, natural transport mechanisms are effective dispersers because of the ease with which stem fragments produce roots; see question 2.4 rationale (Batcher Undated). Turions and tubers can survive ingestion by waterfowl (Batcher Undated).
Sources of information: See cited literature.

Question 2.7 Other regions invaded *Score:* **B** *Doc'n Level:* **Other pub.**
Identify other regions: Wide amplitude of aquatic conditions are infested in North America.
Rationale: *Hydrilla verticillata* can infest any freshwater aquatic system in California from desert waters to upper estuaries to mountain lakes (Godfrey 2000). *Hydrilla verticillata* also infests the cool

temperate waters of Washington (Seattle area), Connecticut, and Cape Cod, Massachusetts (Washington State Department of Ecology Undated, Invasive Plant Atlas of New England Undated), and the warm temperate and humid subtropical areas of the southeastern U.S. (USDA 2005). *Hydrilla verticillata* rarely establishes in swift-flowing water (Batcher Undated)**.** Because of the asexual perennial reproductive traits of hydrilla, this species appears to be adapted to any permanent freshwater system in the U.S. where tubers can survive winter freezing. All freshwater systems—lakes, ponds, reservoirs, rivers, and streams—in Arizona are susceptible to invasion by hydrilla.
Sources of information: See cited literature. Also considered information from the Washington State Department of Ecology, Water Quality website: General Information About Hydrilla (Undated; available online at: http://www.ecy.wa.gov/programs/wq/plants/weeds/*Hydrilla*.html; accessed March 2004) and Invasive Plant Atlas of New England. *Hydrilla verticillata* (Undated; available online at: http://webapps.lib.uconn.edu/ipane/browsing.cfm?descriptionid=22; accessed March 2004).

Question 3.1 Ecological amplitude *Score:* **U** *Doc'n Level:* **Obs.**
Describe ecological amplitude, identifying date of source information and approximate date of introduction to the state, if known: Limited to permanent freshwater habitats. See question 2.7 rationale.
Rationale: Based on hydrilla's distribution in temperate regions of North America, it seems capable of colonizing any Arizona aquatic site that has a permanent source of water; however, distribution records since its first discovery in west Phoenix during the early 1980s are in the elevation range of 900 to 2500 feet, with none of the infested sites natural water bodies (F. Northam, personal observation, 2004).
Sources of information: Statewide observations by F. Northam (Weed Biologist, Tempe, Arizona, 2004) while serving as Arizona Noxious Weed Program Coordinator from July 2000 to Dec 2003.

Question 3.2 Distribution *Score:* **U** *Doc'n Level:* **Obs.**
Describe distribution: Man-made ponds, water storage structures, irrigation water delivery canals, and retail aquatic plant culture tanks. At present, unknown from natural freshwater systems.
Rationale: Examination of collection records (SEINet 2004; F. Northam, personal observation, 2004) did not uncover any records of hydrilla established in natural waters.
Sources of information: Statewide observations by F. Northam (Weed Biologist, Tempe, Arizona, 2004) while serving as Arizona Noxious Weed Program Coordinator from July 2000 to Dec 2003 and information from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections; accessed March 2004).

Worksheet A. Reproductive Characteristics

Complete this worksheet to answer Question 2.4.

Reaches reproductive maturity in 2 years or less	**Yes**	**No**	**1 pt.**
Dense infestations produce >1,000 viable seed per square meter	**Yes**	**No**	**2 pt.**
Populations of this species produce seeds every year.	**Yes**	**No**	**1 pt.**
Seed production sustained for 3 or more months within a population annually	**Yes**	**No**	**1 pt.**
Seeds remain viable in soil for three or more years	**Yes**	**No**	**2 pt.**
Viable seed produced with *both* self-pollination and cross-pollination	**Yes**	**No**	**1 pt.**
Has quickly spreading vegetative structures (rhizomes, roots, etc.) that may root at nodes	**Yes**	**No**	**1 pt.**
Fragments easily and fragments can become established elsewhere	**Yes**	**No**	**2 pt.**
Resprouts readily when cut, grazed, or burned	**Yes**	**No**	**1 pt.**

Total pts: 6 Total unknowns: 3

Score : A

Note any related traits: Seed production is not considered an important part of hydrilla reproduction.

Worksheet B. Arizona Ecological Types

(*sensu* Brown 1994 and Brown et al. 1998)

Major Ecological Types	Minor Ecological Types	Code*
Dunes	dunes	
Scrublands	Great Basin montane scrub	
	southwestern interior chaparral scrub	
Desertlands	Great Basin desertscrub	
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	
Grasslands	alpine and subalpine grassland	
	plains and Great Basin shrub-grassland	
	semi-desert grassland	
Freshwater Systems	lakes, ponds, reservoirs	**U**
	rivers, streams	**U**
Non-Riparian Wetlands	Sonoran wetlands	
	southwestern interior wetlands	
	montane wetlands	
	playas	
Riparian	Sonoran riparian	
	southwestern interior riparian	
	montane riparian	
Woodlands	Great Basin conifer woodland	
	Madrean evergreen woodland	
Forests	Rocky Mountain and Great Basin subalpine conifer forest	
	montane conifer forest	
Tundra (alpine)	tundra (alpine)	

*A means >50% of type occurrences are invaded; B means >20% to 50%; C means >5% to 20%; D means present but ≤5%; U means unknown (unable to estimate percentage of occurrences invaded).

Literature Cited

Batcher, M.S. Undated. *Hydrilla verticillata* (L.F.) Royle. Element Stewardship Abstract. The Nature Conservancy. Available online at: http://tncweeds.ucdavis.edu/esadocs/documnts/hydrver.rtf; accessed March 2004.

Brown, D.E. (ed.). 1994. Biotic Communities: Southwestern United States and Northwestern Mexico. University of Utah Press, Salt Lake City. 342 p. [Plus companion 60-inch by 48-inch map, Biotic Communities of the Southwest].

Brown, D., F. Reichenbacher, and S. Franson, S. 1998. A Classification of North American Biotic Communities. University of Utah Press, Salt Lake City. 141 p.

Colle, D.E., and J.V. Shireman 1980. Coefficients of condition for largemouth bass, bluegill and redear sunfish in *Hydrilla*-infested lakes. Trans. Amer. Fish. Soc. 109:521–531

de Winton, M.D., and J.S. Clayton. 1996. The impact of native submerged weed species on seed banks in lake sediments. Aquatic Botany 53:31–45.

Esler D. 1989. An assessment of American coot herbivory of *Hydrilla*. Journal of Wildlife Management 53: 1147–1149.

Fischer, J.R., L.A. Lewis-Weis, and C.M. Tate. 2003. Experimental vacuolar myelinopathy in red-tailed hawks. Journal Wildlife Diseases 329:400–406.

Godfrey, K. 2000. *Hydrilla verticillata*. Pages 218–221 in C.C. Bossard, J.M. Randall, and M.C. Hoshovsky (eds.), Invasive Plants of California's Wildlands. University of California Press, Berkeley.

Haller, W.T., and D.L. Sutton. 1975. Community structure and competition between *Hydrilla* and *Vallisneria*. Hyacinth Control Journal 13:48–50.

Johnson, F.A., and F. Montalbano. 1984. Selection of plant communities by wintering waterfowl on Lake Okeechobee, Florida. Journal of Wildlife Management 48:174–178.

Kearney, T.H., and R.H. Peebles (and collaborators). 1960. Arizona Flora. 2nd edition with supplement by J.T. Howell and E. McClintock and collaborators. University of California Press, Berkeley. 1085 p.

Langeland, K.A. 1996. *Hydrilla verticillata*…."The Perfect Aquatic Weed." Castena 61:293–304. Available online at: http://aquatic1.ifas.ufl.edu/hydcirc.html.

Langeland, K.A., and D.L. Sutton. 1980. Regrowth of *Hydrilla* from axillary buds. Journal of Aquatic Plant Management 18:27–29

Rocke, T.E., N.J. Thomas, T. Augspurger, and K. Miller. 2002. Epizootiologic studies of avian vascular myelinopathy in waterbirds. Journal of Wildlife Diseases 38:678–684.

Spencer, D.F., and G. G. Ksander. 2000. Interactions between American pondweed and monoecious hydrilla grown in mixtures. Journal of Aquatic Plant Management 38:5–13.

Thomas, N.J., C.U. Meteyer, and L. Sileo. 1998. Epizootic vacuolar myelinopathy of the central nervous system of bald eagles and American coots. Veterinary Pathology 35:479–478.

[USDA] U.S. Department of Agriculture, Natural Resources Conservation Service. 2005. The PLANTS Database, Version 3.5. Available online at: http://plants.usda.gov. Data compiled from various sources by Mark W. Skinner. National Plant Data Center, Baton Rouge, Louisiana.

Warner, P.J., C. Bossard, M.L. Brooks, J.M. DiTomaso, J.A. Hall, A. M. Howald, D.W. Johnson, J.M. Randall, C.L. Roye, M.M. Ryan, and A.E. Staton. 2003. Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands. Available online at: www.caleppc.org and www.swvma.org. California Exotic Pest Plant Council and Southwest Vegetation Management Association. 24 p.