



## California Pest Rating Proposal for

*Hydrilla verticillata* (L. f.) Royle, hydrilla

Family: Hydrocharitaceae

Current Pest Rating: A

Proposed Pest Rating: A

---

**Comment Period: 9/17/2020 through 11/1/2020**

---

### **Initiating Event:**

*Hydrilla verticillata* has been assigned an A-rating by the California Department of Food and Agriculture, Plant Health and Pest Prevention Services. It is designated as a noxious weed as defined by the California Food and Agricultural Code Section 5004 and is listed in Title 3, California Code of Regulations, Section 4500.

### **History & Status:**

#### **Background:**

*Hydrilla verticillata* is a submerged aquatic plant that can grow in fresh or slightly brackish water. It can be rooted in the substrate by rhizomes or free-floating. Stems are elongated, branched or unbranched, and can form dense mats on the water surface. Plants can survive in water depths up to 12 meters in non-turbid water (Haynes, 2000; USDA/GRIN). Small turions (structures for vegetative reproduction) are produced both on the erect stems above the substrate as scaly buds and as tubers on the subterranean rhizomes.

Leaves of *Hydrilla verticillata* are small (5-20 mm long, 1.2-4 mm wide), sessile, and linear to elliptic and have a pointed apex. Leaves are green, translucent, and whorled, with three to eight leaves per node (DiTomaso and Healy, 2003; Haynes, 2000). Leaves have minutely serrated edges and a conspicuous midrib, often with one or more sharp prickles along the mid-rib (Haynes, 2000). Leaf characteristics can be used to distinguish *Hydrilla verticillata* from the similar submerged plants *Elodea canadensis* and *Egeria densa* (DiTomaso and Healy, 2003).

*Hydrilla verticillata* produces small (1.5-5 mm), white, unisexual flowers that are solitary at the tip of a long stalk arising from the leaf axil. Two biotypes of *Hydrilla verticillata* are present in California: the monoecious biotype, which produces both male and female flowers, and the dioecious biotype, which, in the United States, produces just female flowers (DiTomaso and Healy, 2003). Flowers float to the water surface. Fruits are narrowly cylindrical and indehiscent, containing one to five seeds. Seeds are cylindrical, small (2-3 mm long), smooth, and brown (DiTomaso and Healy, 2003).

---

**Worldwide Distribution:** *Hydrilla verticillata* occurs widely in Africa, temperate and tropical Asia, Australia, and Europe (USDA/GRIN, 2020), although its original native range is unclear (Haynes, 2000). It is naturalized in New Zealand, Mexico, Guam, Fiji, New Caledonia, Central America, and South America (Venezuela). In the United States it was reported to occur as an introduced species in Alabama, California, Connecticut, Delaware, District of Columbia, Florida, Georgia, Louisiana, Maryland, Mississippi, South Carolina, Tennessee, Texas, and Virginia in the Flora of North America treatment by Haynes (2000), and is now also mapped for additional localities in Arizona, Arkansas, Illinois, Indiana, Iowa, Kentucky, Maine, Massachusetts, Missouri, New Jersey, New York, North Carolina, Ohio, Washington, and Wisconsin (EDDMapS, 2020; USDA/PLANTS, 2020).

**Official Control:** *Hydrilla verticillata* appears on the United States Department of Agriculture, Federal Noxious Weed list and is listed as a noxious or prohibited weed in the states of Alabama, Arizona, California, Colorado, Florida, Idaho, Massachusetts, Mississippi, Montana, Nevada, New Hampshire, New Mexico, North Carolina, Oregon, Texas, Vermont, Washington, and Wisconsin (EDDMapS, 2020; USDA/PLANTS, 2020). It is also listed as an invasive aquatic plant in Connecticut, Maine, and South Carolina. *Hydrilla verticillata* is under official control in Florida (Ramey, 2010). *Hydrilla verticillata* is listed as an invasive alien plant by the European Plant Protection Organization (EPPO, 2020).

*Hydrilla verticillata* is under official control in California. Division 4, Chapter 9, Article 9, California Food and Agricultural Code (FAC) Section 6048 provides authority for *Hydrilla verticillata* survey and detection activities and prohibits the production or sale of *Hydrilla verticillata* throughout the state. The counties of Calaveras, Imperial, Lake, Madera, Mariposa, Nevada, Shasta, Tulare, and Yuba are declared eradication areas for *Hydrilla verticillata* (Title 3, California Code of Regulations (3 CCR) Section 3962). Boats and other appliances capable of transporting viable plant parts of *Hydrilla verticillata* are restricted when moving intrastate from infested portions of Imperial, Lake, Nevada, and Yuba counties (3 CCR Section 3410).

California FAC Section 3281 prohibits the entry of *Hydrilla verticillata* into the state and restricts the movement of articles capable of transporting *Hydrilla verticillata*, including boats and other aquatic plants, into the state. *Hydrilla verticillata* is listed as a noxious weed in California (3 CCR 4500).

*Hydrilla verticillata* is designated a prohibited noxious weed seed by the Federal Seed Act (Title 7, Code of Federal Regulations, Section 201.16(b) with zero tolerance in interstate commerce, and is also listed as a prohibited noxious weed seed by Arizona and Nevada (USDA/AMS, 2020).

**California Distribution:** Since 2002, *Hydrilla verticillata* has been collected and submitted to the CDFA Plant Pest Diagnostics Branch a total of 61 times from surveys in the following counties (including collections per county): Alameda (2), Calaveras (2), Imperial (2), Lake (44), Los Angeles (1), Nevada (4), Shasta (1), Sutter (1), Tulare (1), Yuba (3) (CDFA PDR Database, 2020).

Additional collections are recorded in the Calflora Database from 1976-2015. Collections not explicitly associated with CDFA are from the following counties (including collections per county): Calaveras (3), Imperial (21), Lake (10), Mariposa (8), Nevada (1), Placer (1), San Bernardino (1), San Diego (8), San Joaquin (1), Shasta (8), Tehama (1), Tulare (2), Yuba (12) (Calflora Database, 2020). Vouchered

---

collections in the Consortium of California Herbaria database (2020) have additionally been made in Madera, Monterey, San Francisco, and Sonoma counties.

**California Interceptions:** *Hydrilla verticillata* has been intercepted 15 times during quarantine inspections of parcel shipments, in nurseries, and at the border inspection stations (CDFA PDR Database, 2020).

### Consequences of Introduction

#### 1) Climate/Host Interaction: Score is High (3)

*Hydrilla verticillata* occurs in fresh or brackish water in ponds, streams, canals, and lakes. The optimal water temperature for growth is between 20°C-24°C (CABI, 2020). The optimal air temperature for growth of turions and tubers is from 17°C -28°C (63°F-82°F) (Thallen, 1990). In Florida, stems of *Hydrilla verticillata* can grow up to six to eight inches per day (Ramey, 2001).

*Hydrilla verticillata* has been collected from 0-785 meters (about 2,500 feet) above sea level in California (CalFlora Database, 2020). Laboratory studies show that growth of *Hydrilla verticillata* declines as salinity increases, with death occurring at salinity above 6.6% (Haller, Sutton, and Barlowe, 1974).

Stems of *Hydrilla verticillata* typically die in periods of prolonged near-freezing temperatures (DiTomaso and Healy, 2003). Turions can tolerate freezing and can remain viable for several days out of water and for over four years in undisturbed sediment (CABI, 2020; Swearingen and Barger, 2016).

Modelling of habitat suitability (Barnes et al., 2014) suggests that the species could establish much more extensively in the state of California in the absence of active control measures, as it can grow successfully in a variety of water conditions and can photosynthesize under very low light.

Evaluate if the pest would have suitable hosts and climate to establish in California

- Low (1) Not likely to establish in California; or likely to establish in very limited areas
- Medium (2) may be able to establish in a larger but limited part of California
- **High (3) likely to establish a widespread distribution in California**

#### 2) Known Pest Host Range: Score is High (3)

*Hydrilla verticillata* can occur wherever general ecological conditions exist that are conducive to its survival.

- Low (1) has a very limited host range
  - Medium (2) has a moderate host range
  - **High (3) has a wide host range**
-

**3) Pest Dispersal Potential: Score is High (3) .**

*Hydrilla verticillata* reproduces asexually by vegetative growth from stem fragments and stem turions. Stem turions can sprout from the above ground portions of the stem, from free-floating plant fragments, and from rhizomes below the substrate. Monoecious plants often produce more turions than dioecious plants and older plant material produces more turions than younger material. Production of seeds is not known to occur in California (DiTomaso and Healy, 2003; Thallen, 1990).

Turions detach from stems and can grow into new plants. Separated turions and stem fragments can be dispersed through water movements, as contaminants on boats, fishing gear, and other equipment, or as contaminants in ornamental or nursery plants (USDA/GRIN, 2020).

Evaluate the natural and artificial dispersal potential of the pest.

- Low (1) does not have high reproductive or dispersal potential
- Medium (2) has either high reproductive or dispersal potential
- **High (3) has both high reproduction and dispersal potential**

**4) Economic Impact: Score is High (3)**

Stems of *Hydrilla verticillata* branch profusely near the water surface, often forming impenetrable mats of vegetation. The dense mats can impede navigation and hydroelectric production, reduce recreational boating, fishing, and swimming opportunities, reduce flow in irrigation canals, and clog industrial and irrigation pipes and intake grates (Swearingen and Barger, 2016).

Treatment and/or control of *Hydrilla verticillata* can increase agricultural production costs due to the use of aquatic herbicides, dredging or sediment removal, and inspections and surveys (DiTomaso and Kyser, 2013). Shipments moving into or within California that are found to be infested with *Hydrilla verticillata* are subject to being refused entry, returned to the owner, quarantined, treated, or destroyed at the expense of the owner.

- A. The pest could lower crop yield.**
- B. The pest could lower crop value (includes increasing crop production costs).**
- C. The pest could trigger the loss of markets (includes quarantines).**
- D. The pest could negatively change normal cultural practices.**
- E. The pest can vector, or is vectored, by another pestiferous organism.
- F. The organism is injurious or poisonous to agriculturally important animals.
- G. The organism can interfere with the delivery or supply of water for agricultural uses.**

Economic Impact:

---

- Low (1) causes 0 or 1 of these impacts
- Medium (2) causes 2 of these impacts
- **High (3) causes 3 or more of these impacts**

**5) Environmental Impact: Score is High (3)**

Dense infestations of hydrilla can shade or crowd out all other native aquatic plants, alter water chemistry, cause dramatic swings in dissolved oxygen levels, increase water temperatures, and affect the diversity and abundance of fish populations (CABI, 2020).

- A. The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes.**
- B. The pest could directly affect threatened or endangered species.**
- C. The pest could impact threatened or endangered species by disrupting critical habitats.**
- D. The pest could trigger additional official or private treatment programs.**
- E. The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.

Environmental Impact:

- Low (1) causes none of the above to occur
- Medium (2) causes one of the above to occur
- **High (3) causes two or more of the above to occur**

Consequences of introduction to California for *Hydrilla verticillata*: **High (15)**

Low = 5-8 points

Medium = 9-12 points

**High = 13-15 points**

**1) Post Entry Distribution and Survey Information: Score is Medium (2)**

*Hydrilla verticillata* is only known from a small subset of waterways and water bodies that could support it. It has been eradicated from several counties and is under active control in the others where it has been detected.

- Not established (0) Pest never detected in California or known only from incursions.
- Low (-1) Pest has a localized distribution in California or is established in one suitable climate/host area (region).
- Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.**
- High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

**7) Final Score: High (13) 15-2=13**

---

**Conclusion and Rating Justification:** Ongoing official control activities for *Hydrilla verticillata* in California have resulted in eradication from some counties and substantial reduction in the other known populations. Because of the continued risk to waterways and aquatic habitats in California from this species, an A-rating is recommended.

#### References:

Barnes, M. A., et al. 2014. Geographic selection bias of occurrence data influences transferability of invasive *Hydrilla verticillata* distribution models. *Ecology and Evolution* 4(12):2584-2593.  
<https://onlinelibrary.wiley.com/doi/abs/10.1002/ece3.1120>. Accessed September 16, 2020.

Calflora Database. 2020. Berkeley, California. Information on California plants for education, research and conservation, with data contributed by public and private institutions and individuals, including the Consortium of California Herbaria. <https://www.calflora.org/cgi-bin/specieslist.cgi?namesoup=hydrilla&countylist=any&plantcomm=any&format=photos&orderby=taxon> Accessed February 5, 2020.

California Department of Food and Agriculture (CDFA), Plant Pest Diagnostics Branch, Pest and Damage Record (PDR) Database. Accessed February 7, 2020.

Centre for Agriculture and Bioscience International (CABI), 2020. *Hydrilla verticillata* Invasive Species Compendium. Wallingford, United Kingdom: CAB International.  
<https://www.cabi.org/isc/datasheet/28170#tosummaryOfInvasiveness> Accessed February 5, 2020.

Consortium of California Herbaria. Accessed August 21, 2020  
<http://ucjeps.berkeley.edu/consortium>

DiTomaso, J. M., Healy, E. 2003. Aquatic and Riparian Weeds of the West. University of California, Agriculture and Natural Resources (ANR), Publication 3421, pp. 96-105.

DiTomaso, J. M. and Kyser, G.B. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California.  
[https://wric.ucdavis.edu/information/natural%20areas/wr\\_H/Hydrilla.pdf](https://wric.ucdavis.edu/information/natural%20areas/wr_H/Hydrilla.pdf) Accessed February 11, 2020.

EDDMapS. 2020. Early Detection and Distribution Mapping System. The University of Georgia, Center for Invasive Species and Ecosystem Health.  
<https://www.eddmaps.org/species/subject.cfm?sub=3028> Accessed September 16, 2020.

European and Mediterranean Plant Protection Organization (EPPO), Lists of Invasive Alien Plants, [https://www.eppo.int/ACTIVITIES/invasive\\_alien\\_plants/iap\\_lists](https://www.eppo.int/ACTIVITIES/invasive_alien_plants/iap_lists) Accessed February 7, 2020.

Haller, W.T., Sutton, D.L., and Barlowe, W.C. 1974. Effects of salinity on growth of several aquatic macrophytes. *Ecology* 55: 891-894.

---

Haynes, R. R. 2000. *Hydrilla* Richard. Pp. 34-45 in Flora of North America (FNA) Editorial Committee (eds.). Flora of North America North of Mexico. Volume 3. New York and Oxford.

[http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=115981](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=115981) Accessed February 5, 2020

Swearingen, J., and Barger, C. 2016. Invasive Plant Atlas of the United States. University of Georgia, Center for Invasive Species and Ecosystem Health. <http://www.invasiveplantatlas.org/>.

Ramey, V. 2001. Center for Aquatic and Invasive Plants, University of Florida, Institute of Food and Agricultural Sciences <http://plants.ifas.ufl.edu/manage/why-manage-plants/floridas-most-invasive-plants/hydrilla/> Accessed February 7, 2020.

Thallen, J. 1990. Production of axillary turions by the dioecious *Hydrilla verticillata*. Journal of Aquatic Plant Management 28: 11-15.

United States Department of Agriculture (USDA), Agricultural Marketing Service (AMS). 2020. State Noxious-Weed Requirements Recognized in the Administration of the Federal Seed Act. <https://www.ams.usda.gov/sites/default/files/media/StateNoxiousWeedsSeedList.pdf> Accessed September 16, 2020.

United States Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS), PLANTS database. 2020. <https://plants.usda.gov/core/profile?symbol=HYVE3> Accessed September 16, 2020.

United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ). 2012. *Federal noxious weed list* <https://plants.usda.gov/java/noxious> Accessed February 1, 2020.

United States Department of Agriculture (USDA), Agricultural Research Service, National Plant Germplasm System. 2019. Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. <https://npgsweb.ars-grin.gov/gringlobal/taxonomydetail.aspx?id=316414> Accessed September 16, 2020.

Author Contact: Courtney.Albrecht@cdfa.ca.gov

**Responsible Party:** Robert Price, Primary State Botanist; California Department of Food & Agriculture; Seed Laboratory and Herbarium; 3294 Meadowview Road, Sacramento, CA 95832; (916) 738-6700; [permits@cdfa.ca.gov](mailto:permits@cdfa.ca.gov).

---

**\*Comment Period: 9/17/2020 through 11/1/2020**

**\*NOTE:**

---

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at [permits\[@\]cdfa.ca.gov](mailto:permits[@]cdfa.ca.gov).

---

**Comment Format:**

- ❖ Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

**Example Comment:**

Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to “Climate/Host Interaction” here.]

- ❖ Posted comments will not be able to be viewed immediately.
  - ❖ Comments may not be posted if they:
    - Contain inappropriate language which is not germane to the pest rating proposal;
    - Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;
    - Violates agency regulations prohibiting sexual harassment or other forms of discrimination;
    - Violates agency regulations prohibiting workplace violence, including threats.
  - ❖ Comments may be edited prior to posting to ensure they are entirely germane.
  - ❖ Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.
- 

**Proposed Pest Rating: A**

---