*Hydrilla verticillata* (L.f.) Royle

# Hydrilla

**Family**: Hydrocharitaceae
**Range**: Tropical to temperate regions on all continents except Antarctica. In the western U.S., it has been found in Washington, California, and Arizona, but is far more common in the southern states.
**Habitat**: Slow-flowing or still water in ditches, sloughs, canals, rivers, ponds, lakes, reservoirs; often in nutrient-rich substrates. Stems can grow to 20 ft deep in clear water column. Hydrilla tolerates low light and variable water quality, including brackish, turbid, and polluted water. The turions survive near freezing temperatures.
**Origin**: Native to the warmer regions of Asia and possibly central Africa. Introduced to the west coast of Florida in 1958.
**Impacts**: Hydrilla can aggressively invade new aquatic environments, displace native aquatic vegetation by forming dense stands or large sub-surface mats, and alter the dynamics of aquatic ecosystems. Other detrimental and economic impacts from heavy infestations can include water flow impediment in waterways, increased flooding, clogged pumps and boat propellers, and reduced use of lakes and waterways for fishing and other recreational activities.
**Western states listed as Noxious Weed**: Arizona, California, Colorado, New Mexico, Nevada, Oregon, Washington. Hydrilla is also on the U.S. Federal Noxious Weed List.
**California Invasive Plant Council (Cal-IPC) Inventory**: High Invasiveness (Alert)

Hydrilla is a submerged aquatic perennial. Its stems typically grow rooted in the substrate. There are many biotypes, including monoecious and dioecious types. Usually monoecious biotypes spread horizontally first, then extend vertically; the dioecious biotypes produce tall vertical shoots first, then spread laterally. The leaves are sessile, whorled, often scale-like and opposite on lower stems. Middle and upper leaves are often 5 to 8-whorled, up to 1 inch long, 1 to 4 mm wide. Leaf margins are minutely toothed, visible with low magnification. Certain nodes on stems and stolons develop adventitious roots, typically at nodes of dormant axillary buds or branches. During brief periods in spring and for longer periods in fall, hydrilla plants often direct some newly formed shoots (from the root crown) straight down into the sediment, and subterranean turions, more commonly called "tubers", form at these shoot tips.

Female flowers extend to the water's surface on thread-like flower tubes several inches long. The sepals and petals are translucent, white to reddish, 3 to 5 mm long. Fruit production and seed set is typically low in hydrilla and seedlings are seldom encountered. As such, nearly all populations of hydrilla in the United States reproduce vegetatively. Stems can easily fragment into free-floating pieces that root at nodes. In addition, plants develop overwintering tubers in the soil substrate, and stem shoots form specialized perennating buds enclosed by tough leaf scales called turions. The stem turions separate from the parent stem in late fall or at maturity. Turions usually germinate readily and survive up to 4 to 5 years under normal aquatic conditions. Tubers can only survive from a few days to weeks under dry conditions. All these vegetative reproductive parts disperse with water and also with human activities, such as fishing and boating.

## NON-CHEMICAL CONTROL

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| **Mechanical** (pulling, cutting, dredging, excavating) | Removing and destroying stem fragments from recreational equipment, such as boat propellers, docking lines, and fishing gear can help prevent the spread of hydrilla.<br>Removing dense canopies by mechanical harvesting may stimulate growth and spread thousands of viable fragments that can disperse, lodge along the bottom or shoreline, and start new populations of |

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| | hydrilla.<br>Diver-assisted dredging can be very effective in small areas (< 2 acres). Since populations over a year old will have already produced a very large "tuber bank" in the sediment, dredging or excavation to remove at least 18 inches of sediment is recommended if eradication is the goal. |
| **Cultural** | Preventing introduction and spread is critical to avoiding long-term impacts and costs of controlling hydrilla. Imported benign plants can harbor hydrilla fragments and even tubers and turions. Careful inspection is critical.<br>Dewatering (drawdown) during mid-summer can reduce the potential for production of a viable tuber bank. Dewatering in winter alone has little effect since tubers usually form 0.5 to 1.5 ft below the sediment. Dewatering coupled with sediment-applied herbicides can be effective (see chemical control options). |
| **Biological** | The most effective biological control agent is the triploid (sterile) grass carp (white amur). Grass carp is a relatively nonselective herbivorous fish that will consume several species of submersed plants. It has been used for management and as part of hydrilla eradication programs in California since 1985. Several host-specific herbivorous insects have been released in the United States, including the flies *Hydrellia pakistanae* and *Hydrellia balciunasi*, a moth *Paraponyx dimunutalis*, and the tuber feeding weevil *Bagous affinis*. These insects have shown variable efficacy but should be considered if long-term management (not eradication) is the goal. The native fungal pathogen *Mycoleptodiscus terrestris* ("MT") has been investigated for 20 years but to date no efficacious product has been developed. |

### CHEMICAL CONTROL

The following specific use information is based on published papers and reports by researchers and land managers. Other trade names may be available, and other compounds also are labeled for this weed. Directions for use may vary between brands; see label before use. Herbicides are listed by mode of action and then alphabetically. The order of herbicide listing is not reflective of the order of efficacy or preference.

| **BRANCHED-CHAIN AMINO ACID INHIBITORS** | |
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| Bispyribac-sodium<br>*Tradewind* | **Rate:** For in-water treatment: 20 to 45 ppb<br>**Timing:** Apply directly to water from early spring to early summer during the period of rapid growth. Repeat applications, no less than 14 days after last application, may be needed to achieve target concentration.<br>**Remarks:** Maximum of four applications per year. Slow activity, requires 2 to 6 weeks to get full effect. Can increase some natives due to selective effects. Residual in water is 2 to 3 months. |
| Imazamox<br>*Clearcast* | **Rate:** For in-water treatment: 150 to 200 ppb; 50 to 75 ppb can be effective if applied in early spring, but repeat application is generally necessary at these lower rates. For drawdown (dewatered) treatment: 64 oz product/acre (0.5 lb a.e./acre); first flush of water in canals must NOT be used for irrigation<br>**Timing:** Apply directly to water from early spring to early summer during the period of rapid growth. For dewatered treatments, apply in late winter at least 14 days before water will be reintroduced.<br>**Remarks:** Use an approved surfactant. Aerial application is approved in some states. |
| Penoxsulam<br>*Galleon* | **Rate:** For in-water treatment: 25 to 75 ppb. Repeat treatments may be required, but not to exceed 150 ppb in an annual season. For drawdown (dewatered) treatment: 5.6 to 11.2 oz product/acre (1.4 to 2.8 oz a.i./acre)<br>**Timing:** Apply directly to water from early spring to early summer during the period of rapid growth. For drawdown treatment, apply during mid- to late winter before refilling.<br>**Remarks:** Penoxsulam is a slow-acting herbicide and may take 4 to 6 week for effective control. For drawdown applications use 20 to 100 gal/acre to wet the sediment. |
| **PIGMENT SYNTHESIS INHIBITORS** | |
| Fluridone<br>*Sonar* | **Rate:** For in-water treatment: 5 to 20 ppb, but exposures must be maintained for 6 to 8 weeks for optimal control.<br>**Timing:** Apply directly to water from early spring to early summer.<br>**Remarks:** Fluridone is a systemic herbicide. It affects young, rapidly growing plants. Lower rates can be used if applied during early spring growth and when water movement is not likely to dilute or move the herbicide. Due to the development of resistance to fluridone in some hydrilla populations, careful monitoring of efficacy is required, and alternative active ingredients should be used periodically as part of an integrated |

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| | management program. |
| **CONTACT PHOTOSYNTHETIC INHIBITORS** | |
| Diquat<br>*Reward* | **Rate:** For in-water treatment: 0.1 to 0.25 ppm<br>**Timing:** Apply directly to water from late spring to early summer.<br>**Remarks:** Diquat is a fast-acting contact herbicide that can be effective in mid- to late summer, but if biomass is large, only a portion of the infested sites should be treated to minimize effects of reduced dissolved oxygen. Diquat is quickly bound to, and becomes inactivated on, suspended clay particles and it should not be used in moderately or highly turbid water. |
| Flumioxazin<br>*Clipper* | **Rate:** For in-water treatment: 100 to 400 ppb<br>**Timing:** Apply directly to water from early spring to early summer. Fall applications may also be effective if temperatures remain high.<br>**Remarks:** Do not use flumioxazin if pH is > 8.0. If pH is high, use a buffer to reduce it below 8. To minimize effects of high pH, apply from dawn to mid-morning. Due to photosynthesis of aquatic plants and algae, pH in the water column rises from mid-day to dusk under most circumstances. |
| **GENERAL CELL TOXICANT** | |
| Acrolein<br>*Magnacide H* | **Rate:** For in-water treatment: 1 to 15 ppm. The recommended rate is variable and depends on target weeds, temperature and flow rates<br>**Timing:** Apply directly to water in late spring to fall and use no more than 8 applications per year.<br>**Remarks:** Acrolein is a very fast-acting, nonselective contact herbicide and algaecide. It is a "Restricted Use" pesticide but can be used in some irrigation canals under specific conditions, with proper permits, and may only be applied by qualified, trained applicators with proper protective clothing. Symptoms of efficacy may appear in less than an hour and include discoloration of leaves and loss of turgidity. |
| Endothall<br>*Cascade; Teton; Aquathol K* | **Rate:** For in-water treatment: 0.2 to 5.0 ppm (e.g., flowing water in irrigation canals). For effective control, exposures must be maintained for 6 to 120 hours. Duration of contact depends on the concentration achieved.<br>**Timing:** Apply directly to water from early spring to early summer. Endothall can be used in mid-summer, but if biomass is heavy, partial treatments are recommended in order to prevent large reduction in dissolved oxygen.<br>**Remarks:** Endothall is a selective, contact herbicide. It affects young, rapidly growing plants and mature plants. Lower rates can be used if applied during early spring growth and when water movement is not likely to dilute or move the herbicide. |
| **INORGANIC HERBICIDES** | |
| Chelated copper<br>*Komeen, Cutrine-Plus* | **Rate:** For in-water treatment: 0.5 to 1 ppm elemental copper<br>**Timing:** Apply directly to water in early summer when plants and biomass are small.<br>**Remarks:** Chelated copper is a fast-acting contact herbicide. Retreatment may be required within 3 to 5 weeks. If biomass is large, treat only one-third of infested area to minimize decrease in dissolved oxygen. Chelated copper products are less affected by high pH compared to inorganic copper. |
| **NON-HERBICIDAL CHEMICAL** | |
| Dyes or colorants<br>*Aquashade* | Although technically not herbicides, dyes and colorants control submerged aquatic plants by absorbing light in the water column and reducing photosynthesis. Applications should be made in early spring and repeated to maintain concentration recommended on the label. Colorants are not as effective on well-established plants in mid- to late summer. |

**RECOMMENDED CITATION:** DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States*. Weed Research and Information Center, University of California. 544 pp.