

<b>Taxon:</b> Ceratophyllum demersum	<b>Family:</b> Ceratophyllaceae
<b>Common Name(s):</b> common hornwort coontail hornwort rigid hornwort	<b>Synonym(s):</b> Ceratophyllum aquaticum Ceratophyllum cornutum Rich.

<b>Assessor:</b> Chuck Chimera	<b>Status:</b> Assessor Approved	<b>End Date:</b> 8 Oct 2015
<b>WRA Score:</b> 20.0	<b>Designation:</b> H(HPWRA)	<b>Rating:</b> High Risk

**Keywords:** Aquatic Weed, Spiny Fruit, Smothering, Spreads Vegetatively, Water-Dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)	y=1, n=0	y
204	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0	y
205	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0	y
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	y
302	Garden/amenity/disturbance weed		
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	y
304	Environmental weed		
305	Congeneric weed		
401	Produces spines, thorns or burrs	y=1, n=0	y
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals		
406	Host for recognized pests and pathogens		
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
408	Creates a fire hazard in natural ecosystems	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	y
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)		
411	Climbing or smothering growth habit	y=1, n=0	y
412	Forms dense thickets	y=1, n=0	n
501	Aquatic	y=5, n=0	y
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally		
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	y
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	1
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	y
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant		
704	Propagules adapted to wind dispersal	y=1, n=-1	n
705	Propagules water dispersed	y=1, n=-1	y
706	Propagules bird dispersed	y=1, n=-1	y
707	Propagules dispersed by other animals (externally)	y=1, n=-1	y
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m <sup>2</sup> )	y=1, n=-1	n
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	n
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	y
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

**Supporting Data:**

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	Source(s)	Notes
	Wilmot-Dear, M. (1985). <i>Ceratophyllum</i> revised: A study in fruit and leaf variation. <i>Kew Bulletin</i> , 40(2): 243-271	[No evidence of domestication] " <i>C. demersum</i> is of worldwide distribution, absent only from arctic, subarctic and arid regions, although the only specimens seen from Malaysia, Polynesia and eastern Asia are either sterile or aberrant (see below) and from the literature it cannot be ascertained whether 'typical' <i>demersum</i> occurs. South American records for the whole genus are rather scanty"

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. 2015. Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. 2015. Personal Communication	NA

Qsn #	Question	Answer
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	High
	Source(s)	Notes
	<p>USDA, ARS, National Genetic Resources Program. 2015. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: <a href="http://www.ars-grin.gov/">http://www.ars-grin.gov/</a>. [Accessed 6 Oct 2015]</p>	<p>"Native:                      AFRICA                      Northern Africa: Egypt                      Northeast Tropical Africa: Chad; Ethiopia; Sudan                      East Tropical Africa: Uganda                      West Tropical Africa: Ghana; Senegal                      South Tropical Africa: Angola; Mozambique                      Southern Africa: South Africa - Western Cape                      ASIA-TEMPERATE                      Middle Asia: Kazakhstan                      China: China - Fujian, Hebei, Heilongjiang, Hubei [s.], Jiangsu, Jilin, Liaoning, Nei Monggol, Ningxia, Yunnan                      Eastern Asia: Taiwan                      EUROPE                      East Europe: Russian Federation - European part                      NORTHERN AMERICA                      Southern Mexico: Mexico - Tabasco                      SOUTHERN AMERICA                      Caribbean: Cuba; Dominican Republic; Trinidad and Tobago - Trinidad                      Mesoamerica: Belize; Costa Rica; El Salvador; Guatemala; Nicaragua                      Northern South America: Guyana; Suriname; Venezuela                      Brazil: Brazil                      Western South America: Bolivia; Colombia; Ecuador; Peru                      Southern South America: Argentina"</p>

202	Quality of climate match data	High
	Source(s)	Notes
	<p>USDA, ARS, National Genetic Resources Program. 2015. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: <a href="http://www.ars-grin.gov/">http://www.ars-grin.gov/</a>. [Accessed 6 Oct 2015]</p>	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	Notes
	<p>CABI, 2015. <i>Ceratophyllum demersum</i>. In: Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a></p>	<p>"C. demersum is a rootless aquatic macrophyte with a cosmopolitan distribution; it has a wide ecological tolerance."</p>
	<p>Staples, G.W. &amp; Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI</p>	<p>[Broad native distribution &amp; climatic range] "...distributed throughout the Northern Hemisphere and sporadically in the rest of the world, in habitats ranging from subarctic to quite tropical."</p>

Qsn #	Question	Answer
204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Cosmopolitan; in Hawai'i naturalized in ponds and reservoirs at least on Maui and Hawai'i. We have seen only a few naturalized collections from Kanaha Pond, Kahului, Maui, and Hilo and Waipi'o Valley, Hawai'i. Further collections are needed to determine island distribution."

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"Apparently only one species is grown in Hawaii, as an aquatic ornamental for aquaria and water gardens."
	CABI, 2015. <i>Ceratophyllum demersum</i> . In: Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	"C. demersum is a cosmopolitan submerged aquatic species that has probably already invaded most of its potential exotic range."
	Zhuang, X. 2013. <i>Ceratophyllum demersum</i> . The IUCN Red List of Threatened Species 2013: e.T164459A17618637. <a href="http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T164459A17618637.en">http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T164459A17618637.en</a> . [Accessed 7 Oct 2015]	"Introduced: Mauritius (Mauritius (main island) - Native); New Zealand (North Is.)"

301	Naturalized beyond native range	y
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Cosmopolitan; in Hawai'i naturalized in ponds and reservoirs at least on Maui and Hawai'i. We have seen only a few naturalized collections from Kanaha Pond, Kahului, Maui, and Hilo and Waipi'o Valley, Hawai'i. Further collections are needed to determine island distribution."
	Staples, G.W., Imada, C.T., & Herbst, D.R. 2002. New Hawaiian plant records for 2000. Bishop Museum Occasional Papers 68: 3-18	"Grown as an aquatic ornamental in Hawai'i at least since 1934, <i>Ceratophyllum demersum</i> was previously known to have become naturalized in Kanahā Pond, Maui, and in Waipi'o Valley, Hawai'i. The following collection documents its presence as a naturalized plant in the Salt Lake area of O'ahu. Elsewhere in these Records it is documented as naturalized on West Maui (Oppenheimer & Bartlett, 2002). Material examined. O'AHU: Honolulu Distr., growing in Salt Lake periphery channel with <i>Bacopa</i> and <i>Ipomoea aquatica</i> ; the colony covered about one acre, 3 Oct 2000, E. Funk s.n. (BISH 666283)."
	Oppenheimer, H. L. & Bartlett, R. T. 2002. New plant records from the main Hawaiian Islands. Bishop Museum Occasional Papers. 69: 1-14	"Wagner et al. (1999: 533) stated that this aquatic has been collected at Kanaha Pond, Maui, and Hilo and Waipi'o Valley on the island of Hawai'i. The following collection extends the known range of this species to West Maui, where it dominates the bottom of a lagoon in a resort golf course. Material examined. MAUI: West Maui, Lahaina Distr., Hanakaoo, 6 m, S end of lagoon, Kaanapali Resort, 14 Oct 1999, Oppenheimer H109906."

Qsn #	Question	Answer
302	Garden/amenity/disturbance weed	
	Source(s)	Notes
	CABI, 2015. <i>Ceratophyllum demersum</i> . In: Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	[Disturbance adapted with negative economic impacts. See 3.03] "When water is disturbed, it is quite common for native species to increase their growth and become a threat to human use of the water body."

303	Agricultural/forestry/horticultural weed	Y
	Source(s)	Notes
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"It is only when drastic environmental changes occur, especially enhanced nutrient supply, that the plant becomes weedy and may require remedial action. In such situations plant density may increase sufficiently to reduce stream flow, interfere with navigation, fishing and hydro-electric output."
	CABI, 2015. <i>Ceratophyllum demersum</i> . In: Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	"When water is disturbed, it is quite common for native species to increase their growth and become a threat to human use of the water body. Frequently, disturbance results from an increase in the trophic level of the water or the substrate. <i>C. demersum</i> has become locally troublesome on several occasions (Cook, 1990). It is one of the 26 aquatic vascular plant species that Cook (1985) characterized as 'very widespread'. It affects fish production in Thailand (Chomchalow and Pongpangan, 1973)."

304	Environmental weed	
	Source(s)	Notes
	Erickson, T.A. & Puttock, C.F. 2006. Hawai'i Wetland Field Guide: An Ecological And Identification Guide to Wetlands And Wetland Plants of the Hawaiian Islands. Bess Press Books, Honolulu, HI	[Not regarded as a serious environmental weed in the Hawaiian Islands] "In the Hawaiian Islands, it is found on Oahu, Maui and Hawaii. First collected on Oahu in 1934, it is now common in ponds, reservoirs, canals and taro patches from near sea level to 10m elevation. Introduced passive-invasive."
	CABI, 2015. <i>Ceratophyllum demersum</i> . In: Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	[Potentially. Primarily impacts human uses. See 3.03] "When water is disturbed, it is quite common for native species to increase their growth and become a threat to human use of the water body." ... "Several reports indicate that <i>C. demersum</i> may exert allelopathic effects on its environment. Most workers have studied the effects of plant extracts and often have not considered whether these allelopathic substances actually leave the live plants and exert their effects in situ. For example, aqueous extracts showed inhibitory effects on seed development of test plants, such as <i>Lepidium sativum</i> (Kleiven and Scepanska, 1988) and on seedling radicle growth of lettuce cv. Black Seeded Simpson (Elakovich and Wooten, 1989). Elemental Sulphur has been shown to be present inside the plant and, on release, can be very toxic to, for example, periphyton (Wium-Andersen et al., 1983). On the other hand, <i>C. demersum</i> was sensitive to the presence of <i>Hydrilla verticillata</i> in its neighbourhood (Kulshreshta and Gopal, 1983)."

305	Congeneric weed	
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Other weeds: ... <i>Ceratophyllum muricatum</i> , <i>C. submersum</i> " [Potentially. Impacts not specified and presumably less significant than those of <i>C. demersum</i> ]

401	Produces spines, thorns or burrs	y
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R. & Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Achenes with spines] "Achenes ellipsoid, compressed, 4-6 mm long, wingless, with 2 basal spines 2-5 mm long."

402	Allelopathic	
	<b>Source(s)</b>	<b>Notes</b>
	CABI, 2015. <i>Ceratophyllum demersum</i> . In: Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	[Potentially] "Several reports indicate that <i>C. demersum</i> may exert allelopathic effects on its environment. Most workers have studied the effects of plant extracts and often have not considered whether these allelopathic substances actually leave the live plants and exert their effects in situ. For example, aqueous extracts showed inhibitory effects on seed development of test plants, such as <i>Lepidium sativum</i> (Kleiven and Scepanska, 1988) and on seedling radicle growth of lettuce cv. Black Seeded Simpson (Elakovich and Wooten, 1989). Elemental sulphur has been shown to be present inside the plant and, on release, can be very toxic to, for example, periphyton (Wium-Andersen et al., 1983). On the other hand, <i>C. demersum</i> was sensitive to the presence of <i>Hydrilla verticillata</i> in its neighbourhood (Kulshreshta and Gopal, 1983)."

403	Parasitic	n
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R. & Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Submerged, aquatic, rootless perennial herbs, without secondary growth; stems branched." [Ceratophyllaceae. No evidence]

404	Unpalatable to grazing animals	n
	<b>Source(s)</b>	<b>Notes</b>
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"In Australia, this native plant oxygenates the water and provides food for aquatic herbivores, and rarely causes problems." ... "Hornwort dry matter contains 23% protein and has a calorific value of 2742 calories per gram. Thus it has some potential as a stock-feed, either as silage or dried and milled in commercial feeds."

405	Toxic to animals	
	<b>Source(s)</b>	<b>Notes</b>

Qsn #	Question	Answer
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Potentially. Can accumulate toxins in water] "Hornwort dry matter contains 23% protein and has a calorific value of 2742 calories per gram. Thus it has some potential as a stock-feed, either as silage or dried and milled in commercial feeds. At the same time it has a remarkable capacity to concentrate and accumulate sodium, iron, arsenic and strontium from lake waters, indicating that care will be required if it is to be used as a stockfood."
<b>406</b>	<b>Host for recognized pests and pathogens</b>	
	<b>Source(s)</b>	<b>Notes</b>
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Potentially] "It may act as a host for disease-causing organisms and, in Ghana, is recorded as the most favoured food plant of the snail host of the Bilharzia parasite."
<b>407</b>	<b>Causes allergies or is otherwise toxic to humans</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"Used in Ayurveda. Plant juice febrifuge, astringent, cooling, bitter, laxative, antipyretic, antiperiodic. a treatment for biliousness. jaundice, fever, ulcers, scorpion stings. Liniments made from the leaves used to treat dermatitis, elephantiasis. fever and sunburn."
	Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence
<b>408</b>	<b>Creates a fire hazard in natural ecosystems</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Plants entirely submerged"
<b>409</b>	<b>Is a shade tolerant plant at some stage of its life cycle</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Hornwort flourishes in shaded, warm and gently flowing (1 cm per second) waters at a pH between 7.6 to 8.8, but does not tolerate turbidity or salinity. Nevertheless, it exhibits a wide tolerance of light conditions, and is able to survive and grow slowly in light intensities of 3 to 3.5 kilolux (about 2% to 3% of full sunlight)."
<b>410</b>	<b>Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)</b>	
	<b>Source(s)</b>	<b>Notes</b>
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[NA. Free-floating & rootless] "A fragile free-floating submerged rootless, but densely leafy, annual or perennial freshwater herb"



Qsn #	Question	Answer
411	Climbing or smothering growth habit	y
	Source(s)	Notes
	CABI, 2015. <i>Ceratophyllum demersum</i> . In: Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	"Impact mechanisms Competition - monopolizing resources Competition - shading Competition - smothering Competition - strangling Filtration Rapid growth"
	DiTomaso, J. M., Kyser, G. B., Oneto, et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California, Davis, CA	[Smothering mats] "plants may develop dense sub-surface mats in high nutrient waters, channels, and controlled aquatic systems. Mats can inhibit water flow, block intake screens of water pumps, interfere with recreational activities, and create mosquito habitat."
412	Forms dense thickets	n
	Source(s)	Notes
	CABI, 2015. <i>Ceratophyllum demersum</i> . In: Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	Smothering
501	Aquatic	y
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R. & Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Plants entirely submerged; stems brittle or cord-like and flexuous, 0.5-3 m long, branched, forming large masses."
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Sheltered sites found in standing or slowly moving clear water in ponds, dams, streams and reservoirs, particularly those with silty bottom mud." ... "A fragile free-floating submerged rootless, but densely leafy, annual or perennial freshwater herb, with leaves so crowded at the apices as to give the impression of a bushy animals tail"
502	Grass	n
	Source(s)	Notes
	USDA, ARS, National Genetic Resources Program. 2015. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: <a href="http://www.ars-grin.gov/">http://www.ars-grin.gov/</a> . [Accessed 6 Oct 2015]	"Family: Ceratophyllaceae"

Qsn #	Question	Answer
503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Submerged, aquatic, rootless perennial herbs, without secondary growth; stems branched." [Ceratophyllaceae]

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Submerged, aquatic, rootless perennial herbs, without secondary growth; stems branched." ... "Plants entirely submerged; stems brittle or cord-like and flexuous, 0.5-3 m long, branched, forming large masses. Leaves of seedlings simple, otherwise in whorls of 3-12 per node and dichotomously dissected, variable in length, often 1-2 cm long, ultimate divisions linear."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	Zhuang, X. 2013. <i>Ceratophyllum demersum</i> . The IUCN Red List of Threatened Species 2013: e.T164459A17618637. <a href="http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T164459A17618637.en">http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T164459A17618637.en</a> . [Accessed 7 Oct 2015]	"This species is listed as Least Concern as it occurs in suitable habitat throughout the region and is not subject to any known significant threat."

602	Produces viable seed	y
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Achenes ellipsoid, compressed, 4-6 mm long, wingless, with 2 basal spines 2-5 mm long."
	DiTomaso, J. M., Kyser, G. B., Oneto, et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California, Davis, CA	"Coontail reproduces vegetatively by turions and stem fragments and also by seed."
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"reproducing vegetatively and by seed." ... "Black ellipsoid achenes 4-10 5 mm long, with 2 basal spines 9 to 12 mm long, and surmounted by the persistent spine-like style." ... "The fruit acts as the seed." ... "Although hornwort reproduces both sexually and asexually, the environmental requirements for sexual reproduction limit seed production in many areas."

Qsn #	Question	Answer
603	Hybridizes naturally	
	Source(s)	Notes
	Les, D. H. (1985). The taxonomic significance of plumule morphology in <i>Ceratophyllum</i> (Ceratophyllaceae). <i>Systematic Botany</i> , 10(3): 338-346	[Hybridization possible. Unknown if natural hybridization occurs] "Hybridization also may account for the presence of simple leaves in the plumule of <i>Ceratophyllum e hinatum</i> . Only one F1 hybrid resulted from numerous crosses made between <i>C. demersum</i> and <i>C. echinatum</i> (Les unpubl.), but its plumule morphology was intermediate to both parental types"

604	Self-compatible or apomictic	y
	Source(s)	Notes
	Kubitzki, K., Rohwer, J.G. & Bittrich, V. (eds.). 1993. The Families and Genera of Vascular Plants: Volume II. Flowering Plants. Dicotyledons: Magnoliid, Hamamelid and Caryophyllid Families. Springer-Verlag, Berlin, Heidelberg, New York	"Preliminary crossing studies found several species to be both self- and cross-compatible (Les 1986a). The lack of self-incompatibility permits sexual reproduction in clonal populations. All <i>Ceratophyllum</i> species are monoecious; however, outcrossing rates appear to be low (Les 1988b). Genetic diversity in populations is extremely low, and they are structured genetically as those of apomicts (Les 1989a)."

605	Requires specialist pollinators	n
	Source(s)	Notes
	Kubitzki, K., Rohwer, J.G. & Bittrich, V. (eds.). 1993. The Families and Genera of Vascular Plants: Volume II. Flowering Plants. Dicotyledons: Magnoliid, Hamamelid and Caryophyllid Families. Springer-Verlag, Berlin, Heidelberg, New York	"All <i>Ceratophyllaceae</i> are hyphydrophilous, i.e. pollination takes place entirely below the surface of the water."
	CABI, 2015. <i>Ceratophyllum demersum</i> . In: <i>Invasive Species Compendium</i> . Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	"Flowering does occur in warmer areas: for example, seeds were abundant in Papua New Guinea (Osborne and Polunin, 1986). Pollen transport is hydrophilous [via water]"
	DiTomaso, J. M., Kyser, G. B., Oneto, et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California, Davis, CA	"Male and female flowers develop on the same plant (monoecious). The flowers are submerged, small, solitary and relatively inconspicuous in the leaf axils. Flowers are water-pollinated. Anthers detach and float just below the water surface before releasing pollen, which sinks down to the female flowers below. Pollination is most likely to occur in still water."

Qsn #	Question	Answer
606	Reproduction by vegetative fragmentation	y
	Source(s)	Notes
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"reproducing vegetatively and by seed." ... "The two modes of vegetative reproduction, fragmentation and turion formation, however, are probably the principal means of survival and dispersal generally. The relatively fragile plant readily fragments when disturbed by strong wave motion, foraging animals, or propeller-driven boats. Each fragment, moving with the stream, is capable of forming a new colony."
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"The brittle stems break easily when handled, and lifting or moving large plants in outdoor ponds usually results in much breakage of stems. The plant is easily propagated by breaking 4-6" long stem pieces and transferring them to a suitable body of water."

607	Minimum generative time (years)	1
	Source(s)	Notes
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	[Able to reproduce vegetatively at an early age] "The brittle stems break easily when handled, and lifting or moving large plants in outdoor ponds usually results in much breakage of stems. The plant is easily propagated by breaking 4-6" long stem pieces and transferring them to a suitable body of water."
	DiTomaso, J. M., Kyser, G. B., Oneto, et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California, Davis, CA	[Annual to perennial. Reproduces vegetatively & by seed] "Submersed annual to perennial with somewhat firm, forked bottlebrush-like leaves and stems to ~8 ft long. Plants lack roots and exist free-floating or anchored to the substrate by specialized, finely divided buried stems (rhizoid shoots). Young seedlings detach from the soil substrate when stems are about 4 inches long, and must absorb nutrients directly from the water. The stems are slender, branched, with only one branch per node. The stems usually fragment easily. The leaves are sessile, 5 to 12 whorled at each node, mostly forked 2-3 times, with margins that are conspicuously small-toothed. Turions (overwintering buds) consist of dense clusters of scale-like leaves at the stem tips."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	Notes
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Where seed is produced the hooked spines on the fruit catch in waders' clothing and in water birds' feathers and may be carried some distance in this way."

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"As a cultivated ornamental, hornwort thrives in outdoor ponds, especially if fed by streams or rainwater." ... "Pet stores frequently sell bunches of 4-6" long stems, tied and weighed down at one end, which people try to "plant" in their aquaria."

Qsn #	Question	Answer
	DiTomaso, J. M., Kyser, G. B., Oneto, et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California, Davis, CA	"Plants are sometimes sold as an aquarium or pond ornamental."

703	Propagules likely to disperse as a produce contaminant	
	Source(s)	Notes
	Erickson, T.A. & Puttock, C.F. 2006. Hawai'i Wetland Field Guide: An Ecological And Identification Guide to Wetlands And Wetland Plants of the Hawaiian Islands. Bess Press Books, Honolulu, HI	[Potential contaminant of taro crops] "now common in ponds, reservoirs, canals and taro patches from near sea level to 10 m elevation."

704	Propagules adapted to wind dispersal	n
	Source(s)	Notes
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Water dispersed] "The two modes of vegetative reproduction, fragmentation and turion formation, however, are probably the principal means of survival and dispersal generally. The relatively fragile plant readily fragments when disturbed by strong wave motion, foraging animals, or propeller-driven boats. Each fragment, moving with the stream, is capable of forming a new colony. Turions may also travel considerable distances in stream flow, either attached to stem fragments or as individuals, while sinking slowly to the bottom mud."

705	Propagules water dispersed	y
	Source(s)	Notes
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"The two modes of vegetative reproduction, fragmentation and turion formation, however, are probably the principal means of survival and dispersal generally. The relatively fragile plant readily fragments when disturbed by strong wave motion, foraging animals, or propeller-driven boats. Each fragment, moving with the stream, is capable of forming a new colony. Turions may also travel considerable distances in stream flow, either attached to stem fragments or as individuals, while sinking slowly to the bottom mud."

706	Propagules bird dispersed	y
	Source(s)	Notes
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Birds, after diving, sometimes carry small fragments of the stem on their beaks for short distances."

Qsn #	Question	Answer
707	Propagules dispersed by other animals (externally)	y
	Source(s)	Notes
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Where seed is produced the hooked spines on the fruit catch in waders' clothing and in water birds' feathers and may be carried some distance in this way."

708	Propagules survive passage through the gut	n
	Source(s)	Notes
	DiTomaso, J. M., Kyser, G. B., Oneto, et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California, Davis, CA	[Dispersed by water & externally] "Coontail reproduces vegetatively by turions and stem fragments and also by seed. Fruits and turions sink to the bottom when separated from the parent plant. Fruits and vegetative parts disperse to greater distances with water or by clinging to the fur, feathers, or feet of animals."

801	Prolific seed production (>1000/m2)	n
	Source(s)	Notes
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Although hornwort reproduces both sexually and asexually, the environmental requirements for sexual reproduction limit seed production in many areas."

802	Evidence that a persistent propagule bank is formed (>1 yr)	n
	Source(s)	Notes
	Boedeltje, G. E. R., Bakker, J. P., Ten Brinke, A., Van Groenendael, J. M., & Soesbergen, M. (2004). Dispersal phenology of hydrochorous plants in relation to discharge, seed release time and buoyancy of seeds: the flood pulse concept supported. <i>Journal of Ecology</i> , 92(5): 786-796	"It is worth noting that several aquatic species that were aquatically dispersed by vegetative organs, including <i>Apium inundatum</i> , <i>C. demersum</i> , <i>E. nuttallii</i> , <i>G. maxima</i> , <i>Mentha aquatica</i> , <i>M. spicatum</i> , <i>P. berchtoldii</i> , <i>P. natans</i> and <i>Ranunculus circinatus</i> , were not found in the propagule banks of backwaters along the research canal (Boedeltje et al. 2003b)."
	Kozlowski, T.T. (ed.). 1972. Seed Biology. Volume III. Insects, and Seed Collection, Storage, Testing, and Certification. Academic Press, New York	"Table 1. Plant Species with Short-Lived Seeds" [ <i>Ceratophyllum demersum</i> - Longevity (and germination) = 7 mo(73%)]
	Westcott, K., Whillans, T. H., & Fox, M. G. (1997). Viability and abundance of seeds of submerged macrophytes in the sediment of disturbed and reference shoreline marshes in Lake Ontario. <i>Canadian Journal of Botany</i> , 75 (3): 451-456	[Probably No] "Perennial macrophytes including <i>Vallisneria spiralis</i> , <i>Ceratophyllum demersum</i> , and <i>Potamogeton</i> spp., although abundant in the existing vegetation of the reference marshes (Table I), were rare as seeds and seedlings. These results are similar to those of Kautsky (1990) who found that the annual <i>Zannichellia pinnatifida</i> dominated the seed banks of permanently submerged sediments, whereas seeds of resident perennial macrophytes were not well represented in the seed bank."

Qsn #	Question	Answer
	Combroux, I., & Bornette, G. (2004). Propagule banks and regenerative strategies of aquatic plants. <i>Journal of Vegetation Science</i> , 15(1): 13-20	[Recruits from fragments] "The role of the propagule bank in aquatic plant maintenance was studied in two riverine wetlands." ... "Although able to produce seeds or buds, some species maintained in the established vegetation only through regeneration from unspecialized fragments (e.g. <i>Ceratophyllum demersum</i> , <i>Utricularia vulgaris</i> ). They may remain in wet parts of the sediment and regrow into full individuals. The ability to regrow from unspecialized fragments has already been noted in aquatic plants (Sculthorpe 1967; Barrat-Segretain et al. 1999) but the effective resistance of such organs to desiccation is poorly understood. Drying up thus favoured regeneration through an abundant bank of seeds or unspecialized fragments. However, availability of these propagules may change during the year."

803	Well controlled by herbicides	y
	Source(s)	Notes
	CABI, 2015. <i>Ceratophyllum demersum</i> . In: <i>Invasive Species Compendium</i> . Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	" <i>C. demersum</i> could be controlled using the following herbicides: dichlobenil, diquat, diquat + complexed copper, endothal dipotassium salt, endothal + complexed copper, endothal dimethylalkylamine salts (rated as 'excellent'); fluridone, simazine (rated as 'good'); 2,4-D (rated as 'fair') (Westerdahl and Getsinger, 1988). Examples of applications can be found in the literature (Mixon, 1974; Baker et al., 1975; Serns, 1977; Best and Van de Wittenboer, 1978; Patnaik and Das, 1981; Arsenovic et al., 1982; Khattab and El-Gharably, 1986; Wells et al., 1986; Wells and Clayton, 1993)."
	Parsons, W.T. & Cuthbertson, E.G. 2001. <i>Noxious Weeds of Australia</i> . Second Edition. CSIRO Publishing, Collingwood, Australia	"Herbicides provide the most effective means of control. Short exposure chemicals are necessary in most situations to minimise damage to non-target species when the water from treated areas is used subsequently. Acrolein is used extensively by State authorities in major irrigation channels, while diquat and paraquat have given good control in mailer channels and static water."

804	Tolerates, or benefits from, mutilation, cultivation, or fire	y
	Source(s)	Notes
	Parsons, W.T. & Cuthbertson, E.G. 2001. <i>Noxious Weeds of Australia</i> . Second Edition. CSIRO Publishing, Collingwood, Australia	"Where it does become a pest, mechanical harvesting is, in any case, expensive, gives only temporary relief and encourages spread by fragmentation."
	DiTomaso, J. M., Kyser, G. B., Oneto, et al. 2013. <i>Weed Control in Natural Areas in the Western United States</i> . Weed Research and Information Center, University of California, Davis, CA	[Mechanically damaged plants can be the source of future propagules] "Removing and destroying stem fragments from recreational equipment, such as boat propellers, docking lines, and fishing gear can help prevent the spread of coontail. Mechanical harvesting has proved sufficient to control coontail stands in some temperate areas. Several types of "bottom barriers" are available and are used to cover and smother specific infested areas. Materials used include polyvinyl chloride (PVC) sheets, small-mesh screens and natural fibers such as jute. Bottom barriers are best installed in spring before plants produced large biomass and exceed 20 inches tall."

Qsn #	Question	Answer
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	<p style="text-align: center;"><b>Source(s)</b></p> <p>CABI, 2015. <i>Ceratophyllum demersum</i>. In: <i>Invasive Species Compendium</i>. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a></p>	<p style="text-align: center;"><b>Notes</b></p> <p>[Unknown for Hawaiian Islands] "Biological control Triploid grass carp (<i>Ctenopharyngodon idella</i>) were successfully used to control water weeds, including <i>C. demersum</i>, in waterlily production ponds in Brookshire, and in Lake Conroe, both in Texas, USA (Martyn et al., 1986; Santha et al., 1994), in Iowa, USA (Mitzner, 1976), and in Thailand (Pholprasith et al., 1978). Grass carp also proved useful in tropical areas, such as Egypt (Khattab and El-Gharably, 1986). However, palatability of this plant is an issue for grass carp as <i>C. demersum</i> is not high on preferred list of species eaten .In one case when other aquatic plants were available it was not grazed (Pine and Anderson, 1991), but it was grazed on other occasions (Cassani, 1981; Fowler, 1984), although not preferred (Chapman and Coffey, 1971; Edwards, 1975; Colle et al., 1978; Kilambi and Zdinak, 1980; Cassani and Caton, 1983). The rather low efficiency with which the plant material was converted into fish biomass may explain why the fish did not prefer this plant (Venkatesh and Shetty, 1978a, b, c; Kilambi and Zdinak, 1981; Hajra, 1987). The larvae of <i>Parapoynx diminutalis</i>, an Asian pyralid moth adventive on <i>Hydrilla verticillata</i>, were able to remove considerable <i>C. demersum</i> biomass (Buckingham and Bennett, 1989). The nematode <i>Hirschmanniella caudacrena</i> may be pathogenic to <i>C. demersum</i> (Gerber et al., 1986; Gerber and Smart, 1987). Several fungi have been tested to control aquatic weeds. <i>Mycoleptodiscus terrestris</i>, a microbial herbicide candidate for <i>Myriophyllum spicatum</i>, proved pathogenic to <i>C. demersum</i> when applied as alginate beads (Verma and Charudattan, 1993)."</p>



**Summary of Risk Traits:**

## High Risk / Undesirable Traits

- Broad native distribution & climatic range
- Grows in temperate & tropical climates
- Naturalized on Maui, Hawaii, and Oahu
- An aquatic weed that can reduce stream flow, interfere with navigation, fishing and hydro-electric output
- Spiny fruit
- Can accumulate water toxins
- Can act as a host of disease-causing organisms
- Able to smother water surfaces
- Reproduces by seeds & vegetative fragments
- Self-compatible
- Able to reproduce in first year of growth
- Propagules dispersed by water & externally on fur, feathers, or feet of animals as well as by on clothing or water craft
- Sold as an aquarium or pond ornamental
- Mechanical control can result in inadvertent dispersal

## Low Risk Traits

- Palatable to fish & other aquatic animals
- Ornamental
- Does not produce prolific numbers of seeds (although able to spread vegetatively)
- Seeds presumably do not form a persistent seed bank
- Herbicides may provide effective control