Taxon: Nelumbo nucifera Gaertn. **Family:** Nelumbonaceae

Common Name(s): East Indian lotus
lotus
lotusroot
sacred lotus

Synonym(s): Nelumbo caspica Eichw.
Nelumbo komarovii Grossh.
Nelumbo speciosa Willd.
Nymphaea nelumbo L.

Assessor: Chuck Chimera **Status:** Assessor Approved **End Date:** 30 Mar 2020

WRA Score: 14.0 **Designation:** H(HPWRA) **Rating:** High Risk

Keywords: Aquatic Herb, Weedy, Ornamental, Edible, Water-Dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	y
102	Has the species become naturalized where grown?	y=1, n=-1	y
103	Does the species have weedy races?	y=1, n=-1	y
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	n=0, y = 1*multiplier (see Appendix 2)	n
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	y
304	Environmental weed		
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals	y=1, n=0	n
406	Host for recognized pests and pathogens	y=1, n=0	n
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	n
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	n
411	Climbing or smothering growth habit	y=1, n=0	y
412	Forms dense thickets		
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	n
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	n
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	n
707	Propagules dispersed by other animals (externally)	y=1, n=-1	n
708	Propagules survive passage through the gut		
801	Prolific seed production (>1000/m2)	y=1, n=-1	n
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	y
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

Supporting Data:

Qsn #	Question	Answer
101	**Is the species highly domesticated?**	**y**
	Source(s)	**Notes**
	Prance, G. & Nesbitt, M. (2005). The Cultural History of Plants. Routledge, New York, NY	"This species is a symbol of purity to Buddhists and has been held sacred in the Far East for over 5000 years. [t originated in continental Asia, but is now distributed worldwide. It has been cultivated in China for over 3000 years and is exported globally."

102	**Has the species become naturalized where grown?**	**y**
	Source(s)	**Notes**
	Flora of North America Editorial Committee, eds. 1997. Flora of North America: Volume 3: Magnoliophyta: Magnoliidae and Hamamelidae. Oxford University Press, Oxford, UK	"Nelumbo nucifera is an ornamental species sporadically naturalized from cultivation over the area mapped in the southeastern United States."

103	**Does the species have weedy races?**	**y**
	Source(s)	**Notes**
	Sathyanathan, N. (2012). Aquatic weed classification, environmental effects and the management technologies for its effective control in Kerala, India. International Journal of Agricultural and Biological Engineering, 5(1): 76 -91	"Table 1 Major aquatic weeds in India" [Includes Nelumbo nucifera. No impacts specified]
	Sitre, S. R. (2014). Aquatic Weed Biodiversity of a Shrinking Freshwater Pond Affected By Anthropogenic Activities in Bhadrawati Town of Chandrapur District (MS) India. Online International Interdisciplinary Research Journal, 4(2): 113-117	"The aquatic weeds are unwanted vegetation which grow in ponds and lakes and hamper its use (Sushilkumar, 2011). Out of 160 aquatic weeds Ipomoea aquatica, Typha angustata, Eichhornia crassipes, Nelumbo nucifera, Alternanthera philoxeroides, Vallisneria spiralis, Chara, Potamogeton , Hydrilla, Ceratophyllum and Salvinia are spread in Indian water bodies to a very large extent that they are a ecological threat to the regions under which they are thriving."

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**
	USDA, Agricultural Research Service, National Plant Germplasm System. (2020). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/. [Accessed 30 Mar 2020]	"Native Asia-Temperate WESTERN ASIA: Iran (n.w.) CAUCASUS: Azerbaijan (e.) RUSSIAN FAR EAST: Russian Federation [Primorye, Amur] CHINA: China (s. & e.) EASTERN ASIA: Japan, Korea, Taiwan Asia-Tropical INDIAN SUBCONTINENT: Bhutan, India, Nepal, Sri Lanka PAPUASIA: Papua New Guinea INDO-CHINA: Myanmar, Thailand, Vietnam MALESIA: Indonesia, Malaysia, Philippines Australasia AUSTRALIA: Australia [Queensland, Northern Territory (n.)] Europe EASTERN EUROPE: Russian Federation-European part [European part (s.e.)]"

202	Quality of climate match data	High
	Source(s)	**Notes**
	USDA, Agricultural Research Service, National Plant Germplasm System. (2020). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/. [Accessed 30 Mar 2020]	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	**Notes**
	Gilman, E.F. (1999). Nelumbo nucifera Lotus. FPS424. IFAS, University of Florida, Gainesville, FL. http://edis.ifas.ufl.edu. [Accessed 30 Mar 2020]	"USDA hardiness zones: 5 through 10 (Fig. 2) Planting month for zone 7: year round Planting month for zone 8: year round Planting month for zone 9: year round Planting month for zone 10: year round"
	Missouri Botanical Garden. (2020). Nelumbo nucifera. http://www.missouribotanicalgarden.org. [Accessed 30 Mar 2020]	"Zone: 4 to 10"

Qsn #	Question	Answer
204	**Native or naturalized in regions with tropical or subtropical climates**	**y**
	Source(s)	**Notes**
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2001. Flora of China. Vol. 6 (Caryophyllaceae through Lardizabalaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Lakes, ponds, cultivated. Throughout China except Nei Mongol, Qinghai, and Xizang [Bhutan, India, Indonesia (Java), Japan, Korea, Malaysia, Myanmar, Nepal, New Guinea, Pakistan, Philippines, Russia (Far East), Sri Lanka, Thailand, Vietnam; SW Asia, Australia]."

205	**Does the species have a history of repeated introductions outside its natural range?**	**y**
	Source(s)	**Notes**
	Roecklein, J.C. & Leung, P. (eds.). (1987). A Profile of Economic Plants. Transaction Publishers, New Brunswick, NJ	"They are grown mainly in Japan, China, Hawaii, and India, and to a limited degree in California. Commercial production in Hawaii has declined since 1967."

301	**Naturalized beyond native 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	"It has escaped and become naturalized in many places outside this range."
	Flora of North America Editorial Committee, eds. 1997. Flora of North America: Volume 3: Magnoliophyta: Magnoliidae and Hamamelidae. Oxford University Press, Oxford, UK	"Nelumbo nucifera is an ornamental species sporadically naturalized from cultivation over the area mapped in the southeastern United States. Although Virginia, Kentucky, and Delaware are within the range, I know of no collections from Virginia or Delaware and of no wild-growing specimens of N . nucifera in Kentucky. The species was listed in a flora of New York (R. S. Mitchell 1986); I have not seen a voucher specimen for the report."
	Wagner, W.L., Herbst, D.R.& Lorence, D.H. (2020). Flora of the Hawaiian Islands. Smithsonian Institution, Washington, D.C. https://naturalhistory2.si.edu/botany/hawaiianflora/. [Accessed 30 Mar 2020]	No evidence in Hawaiian Islands to date
	Imada, C. (2019). Hawaiian Naturalized Vascular Plants Checklist (February 2019 update). Bishop Museum Technical Report 69. Bishop Museum, Honolulu, HI	No evidence to date

302	**Garden/amenity/disturbance weed**	**n**
	Source(s)	**Notes**
	Gilman, E.F. (1999). Nelumbo nucifera Lotus. FPS424. IFAS, University of Florida, Gainesville, FL. http://edis.ifas.ufl.edu. [Accessed 30 Mar 2020]	"Lotus plants are extremely aggressive and should be planted into containers in the water garden to keep them from escaping and permanently rooting into the soil beneath the water. Once they become established in the soil, they are difficult to get rid of. Containerizing plants is a good way to enjoy lotus without the danger of them becoming invasive in the pond or lake."

Qsn #	Question	Answer
	Hilty, J. (2020). Wetland Wildflowers of Illinois - Nelumbo nucifera (Sacred Lotus). http://www.illinoiswildflowers.info/. [Accessed 30 Mar 2020]	"This introduced plant can spread aggressively and completely take over a shallow pond. Some cultivars of the Sacred Lotus are hardy to Zone 5. The seeds of Sacred Lotus can remain viable for several centuries." ... "Thus far, there are no records of the non-native Sacred Lotus escaping from cultivation and naturalizing into new areas within the state of Illinois (see Distribution Map). However, many states in southeastern United States have records of such escaped plants, and there is some evidence that Sacred Lotus has escaped in Ohio, West Virginia, New Jersey, and New York. There is really no reason why this plant can't escape from cultivation in Illinois. Habitats include small ponds and shallow areas of lakes and rivers. Sacred Lotus is native to southern and eastern areas of Asia."

303	Agricultural/forestry/horticultural weed	y
	Source(s)	**Notes**
	Wisconsin Department of Natural Resources. (2019). Sacred Lotus (Nelumbo nucifera). http://dnr.wi.gov/. [Accessed 30 Mar 2020]	"Can affect other wildlife by blocking access to the water and/or reducing plants the animals depend on for shelter and nesting. The dense floating mats of vegetation can negatively affect boating, angling and swimming."
	Colorado Water Garden Society. (2013). Lotus Nelumbo nucifera Planting, Dividing, & Care. http://www.colowatergardensociety.org. [Accessed 24 Nov 2015]	"Lotus are quite hardy, aggressive, somewhat invasive, and may take over the pond if not contained properly. It is important to grow them in containers without holes."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Weed of: Bananas, Cereals, Orchards and Plantations"
	Varshney, J. G., & Sushilkumar, M. J. (2008). Current status of aquatic weeds and their management in India. In: Proceedings of 12th World Lake Conference, Jaipur, pp. 1039–1045, 28 October–2 November 2007	[Considered a major aquatic weed of lakes, reservoirs, & fisheries] "Out of about 140 aquatic weeds, Eichhornia crassipes, Ipomoea aquatica, Typha angustata, Ceratophyllum demersum, Salvinia molesta, Nelumbo nucifera, Alternanthera philoxeroides, Hydrilla verticillata, Vallisneria spiralis,, Chara spp., Nitelia spp., Potamogeton spp. are of primary concern in India." ... "Problems in fishery tanks and ponds and reservoirs: ... Some of the weeds like Eichhornia, Azolla, Nymphaea, Nelumbo, Nymphoides, Hydrilla, Vallisneria, Potamogeton, Najas, Myriophyllum, Ceratophyllum., Typha Utricularia spp. are problematic weeds in fishery lakes and tanks of Andhra Pradesh, Assam, Haryana, Himachal Pradesh, Jammu & Kashmir, Maharashtra, Tamil Nadu and Uttar Pradesh in India." ... "Major weeds in fishery lakes and tanks in Andhra Pradesh are: Eichhornia, Nymphaea, Nelumbo, Nymphoides, Hydrilla, Vallisneria, Potamogeton, Najas, Chara, Typha, and Cyperus spp." ... "In the Tarai area of Uttar Pradesh, the fishery ponds are also losing ground to aquatic weeds like Hydrilla, Potamogeton, Vallisneria, Nelumbo, and Nymphaea spp. Marginal weeds, chiefly Typha, Saccharum and Brachiaria spp. are obstacles to water-bodies."

304	Environmental weed	
	Source(s)	**Notes**

Qsn #	Question	Answer
	Wisconsin Department of Natural Resources. (2019). Sacred Lotus (Nelumbo nucifera). http://dnr.wi.gov/. [Accessed 30 Mar 2020]	[Potential environmental impacts discussed] "Dense mats of floating vegetation can inhibit other native aquatic vegetation, decreasing biodiversity. Can affect other wildlife by blocking access to the water and/or reducing plants the animals depend on for shelter and nesting. The dense floating mats of vegetation can negatively affect boating, angling and swimming."

305	Congeneric weed	y
	Source(s)	**Notes**
	Turner, A. M., Cholak, E. J., & Groner, M. (2010). Expanding American lotus and dissolved oxygen concentrations of a shallow lake. The American Midland Naturalist, 164(1): 1-8	"A review of the literature shows that natural resource managers have a Jekyll and Hyde relationship with the American lotus." ... "...it is listed as ‘‘a noxious and invasive weed’’ in Connecticut and intentional plantings are banned (Connecticut Invasive Plants Council 2004). The species has traits associated with invasive species (sensu Colautti and MacIssac, 2004), as it is capable of rapid expansion (e.g., Whyte et al., 1997), particularly in human-altered habitats, and it likely displaces other species. We have shown here that its expansion has ecosystem level consequences. Such situations in which a native species responds to disturbance with aggressive expansion and displacement of other species raises difficult questions with regard to appropriate management strategies."
	DiTomaso, J. (2006). New Weed Alerts! Cal - IPC News 13 (4): 4-5	"Nelumbo lutea (American lotus) Has taken over much of a 30 acre lake in Tehama County. Need to watch that it does not spread to other areas. Has been invasive in the tropics and the seeds are very long lived, reportedly up to 400 years."
	Bugbee, G. J., Barton, M. E. & Gibbons, J. A. (2012). Connecticut’s Aquatic and Wetland Invasive Plant Identification Guide. 2nd Edition. The Connecticut Agricultural Experiment Station, New Haven, CT	"Table 1. Invasive and potentially invasive aquatic plants listed in the Connecticut General Statutes" [Includes Nelumbo lutea]

401	Produces spines, thorns or burrs	n
	Source(s)	**Notes**
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2001. Flora of China. Vol. 6 (Caryophyllaceae through Lardizabalaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Herbs perennial, aquatic. Rhizomes branched, repent, forming swollen terminal storage tubers late in growing season. Leaves arising from rhizome, alternate, emersed or floating, long petiolate; leaf blade centrally peltate, veins radially extended." ... "Petiole 1–2 m, terete, fistulous, glabrous or papillae hard and scattered; leaf blade abaxially blue-green, orbicular, 25–90 cm in diam., papery, glabrous, glaucous, water-repellent, margin entire."

402	Allelopathic	
	Source(s)	**Notes**

Qsn #	Question	Answer
	Gul, B., Ijaz, S., & Khan, H. (2019). Allelopathic Effect of Lotus and Arrowhead Weed on Wheat, Wild Oat and Milkthistle Germination. Planta Daninha, 37: e019184290	[Extracts demonstrate allelopathic effects] "ABSTRACT - An experiment was conducted to investigate the allelopathic effects of lotus (Nelumbo nucifera Gaertn.) and arrowhead (Sagittaria sagittifolia (Brummitt & Powell): L.) on seed germination of wheat and two associated weeds, namely, wild oat (Avena fatua L.) and milk thistle (Silybum marianum (L.) Gaertn.). The experiment was laid out in a Completely Randomized Design during May, 2014. Dried biomasses of lotus and arrowhead leaves were soaked in distilled water for 48 hrs for extract preparation. The extracts were applied at a rate of 5 and 10% concentrations to the seeds of wheat, wild oat and milk thistle at 25 °C in 10 cm wide Petri plates. A control treatment where only distilled water was applied to the seeds, was included for comparison. Data were recorded on germination (%), shoot length (cm), shoot and root fresh weights (g). The results revealed that 10% lotus extract reduced germination of wild oat (0.00%) and milk thistle (13.3%) but comparatively enhanced that of wheat (20%). By contrast, arrowhead totally inhibited germination of wheat and wild oat as compared to milk thistle (16.66%). Similarly, 10% lotus extract favored shoot length and root weight of wheat and milk thistle, whereas 100% inhibited wild oat. By comparison, arrowhead completely inhibited shoot length and root weight of wheat and wild oat at 10% conc. and enhanced milkthistle (3.00 cm and 3 g). A higher lotus extract conc. affected wild oat more than wheat and milkthistle, while arrowhead weed affected almost all test species. In conclusion, these aquatic weeds can be used as mulch in wheat in nearby fields of the infested aquatic water bodies for wild oat control, weed biomass disposal and nutrient addition to the soil."
	Meng, F. L., He, L. S., Xi, B. D., Li, D. L., Zhang, J. B., & Shu, J. M. (2013). Effect of Leachate from Different Parts of Nelumbo nucifera on the Growth of Three Freshwater Algae. Environmental Science & Technology, 6: 005	[Potentially. Demonstrates allelopathic properties] "Effects of leachate from different parts of Nelumbo nucifera on the growth of Microcystis aeruginosa, Chlorella pyrenoides, Scenedesmus quadricanda were discussed to provide a basis for the allelopathic substances from lotus to reduce lake eutrophication. Results showed that the leachate from different parts of Nelumbo nucifera significantly inhibited the growth of three algae. The lotus leaf had a better inhibitory effect than Nelumbo nucifera stem. The leachate from different parts of Nelumbo nucifera had different effects of half-concentration(EC50) of different algae.EC50 of Microcystis aeruginosa, Chlorella pyrenoides, Scenedesmus quadricanda was 4.21,5.35,9.92 g/L respectively. The leachate from Nelumbo nucifera stem on Microcystis aeruginosa, Chlorella pyrenoides, Scenedesmus quadricanda was 9.52,7.28,6.90 g/L respectively"

403	Parasitic	n
	Source(s)	**Notes**
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2001. Flora of China. Vol. 6 (Caryophyllaceae through Lardizabalaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Herbs perennial, aquatic." [No evidence in Nelumbonaceae]

404	Unpalatable to grazing animals	n

Qsn #	Question	Answer
	Source(s)	**Notes**
	Werner, P. A. (2014). The rise and fall of the Asian water buffalo in the monsoonal tropics of northern Australia. Pp. 452-496 in Herbert H. T. Prins, I. J. Gordon (eds.). Invasion Biology and Ecological Theory: Insights from a Continent in Transformation. Cambridge University Press, Cambridge, UK	[Palatable to grazing animals such as water buffalo. Browsing in Hawaii may be limited due to aquatic habitat] "Highly favoured plants, including most perennial grasses in the savanna woodlands, as well as the grass Hymenachne acutigluma, the reed Phragmites karka and the red water lily Nelumbo nucifera in freshwater floodplains and billabongs, declined in abundance due to buffalo activities (Taylor and Friend 1984)." ..."During the middle of the wet season, buffalo either forage near spring-fed creeks or move out onto the floodplains in the morning and evenings, avoiding the high temperatures of the midday, to feed on floating vegetation mats and emergent plants, including ... the red water lily Nelumbo nucifera..."

405	Toxic to animals	n
	Source(s)	**Notes**
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	No evidence
	Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence

406	Host for recognized pests and pathogens	n
	Source(s)	**Notes**
	Gilman, E.F. (1999). Nelumbo nucifera Lotus. FPS424. IFAS, University of Florida, Gainesville, FL. http://edis.ifas.ufl.edu. [Accessed 30 Mar 2020]	"Pest resistance: long-term health usually not affected by pests"
	Missouri Botanical Garden. (2020). Nelumbo nucifera. http://www.missouribotanicalgarden.org. [Accessed 30 Mar 2020]	"Problems: No serious insect or disease problems. Aphids and red spider mites are occasional pests (fish can help control these, however). Watch for blights."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	**Notes**
	Lim, T.K. (2016). Edible Medicinal And Non-Medicinal Plants. Volume 11, Modified Stems, Roots, Bulbs. Springer, Dordrecht	"Lotus is well known as a food and medicinal plant, and its every part is utilised. All parts of the lotus plant, including flowers, seeds, leaves, stems and roots are consumed (Sridhar and Bhat 2007)"
	Prance, G. & Nesbitt, M. (2005). The Cultural History of Plants. Routledge, New York, NY	"The rhizomes are eaten raw or roasted, sliced and fried as chips, pickled, or candied. In China, the root is also ground into a starchy paste for use as a thickener. The leaves are used as a vegetable and as a wrapping."

Qsn #	Question	Answer
	Roecklein, J.C. & Leung, P. (eds.). (1987). A Profile of Economic Plants. Transaction Publishers, New Brunswick, NJ	[No evidence] "The sacred lotus is a perennial pond herb whose roots are used for culinary purposes and as a source of starch. Lotus roots are 60-120 cm in size and are considered a delicacy in Oriental cooking. Roots are rarely processed for starch because of the high labor requirement involved in harvest. In China, the seed pods are brewed as a medicinal tea. The starchy seeds may also be cooked as food. Sap from the tuber has been used medicinally, while leaf fibers provide lamp wicks."
	Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	**Notes**
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2001. Flora of China. Vol. 6 (Caryophyllaceae through Lardizabalaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[No evidence] "Herbs perennial, aquatic." ... "Lakes, ponds, cultivated."

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	**Notes**
	Gilman, E.F. (1999). Nelumbo nucifera Lotus. FPS424. IFAS, University of Florida, Gainesville, FL. http://edis.ifas.ufl.edu. [Accessed 30 Mar 2020]	"Lotus is a non-native aquatic plant requiring plenty of space and a full sun location to thrive" ... "Light requirement: plant grows in full sun"
	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	"Requirements include a muddy substrate free of rocks and other hard objects, still water 1-3' deep, and a sunny exposure."
	Missouri Botanical Garden. (2020). Nelumbo nucifera. http://www.missouribotanicalgarden.org. [Accessed 30 Mar 2020]	"Sun: Full sun"

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	n
	Source(s)	**Notes**
	Backyard Gardener. (2020). Nelumbo nucifera (Nelumbo Lotus). https://www.backyardgardener.com. [Accessed 30 Mar 2020]	"pH Range: 7 to 8.5 Soil Range: undefined"
	Colorado Water Garden Society. (2013). Lotus Nelumbo nucifera Planting, Dividing, & Care. http://www.colowatergardensociety.org. [Accessed 30 Mar 2020]	"Soil for lotus should be as rich as possible, with some clay, and heavy enough so it does not loosen or float."
	Gilman, E.F. (1999). Nelumbo nucifera Lotus. FPS424. IFAS, University of Florida, Gainesville, FL. http://edis.ifas.ufl.edu. [Accessed 30 Mar 2020]	"Soil tolerances: acidic; grows submerged in water"

411	Climbing or smothering growth habit	y

Qsn #	Question	Answer
	Source(s)	**Notes**
	Wisconsin Department of Natural Resources. (2019). Sacred Lotus (Nelumbo nucifera). http://dnr.wi.gov/. [Accessed 30 Mar 2020]	[Able to smother water surfaces] "Dense mats of floating vegetation can inhibit other native aquatic vegetation, decreasing biodiversity." ... "The dense floating mats of vegetation can negatively affect boating, angling and swimming."

412	Forms dense thickets	
	Source(s)	**Notes**
	Wisconsin Department of Natural Resources. (2019). Sacred Lotus (Nelumbo nucifera). http://dnr.wi.gov/. [Accessed 30 Mar 2020]	[Smothers water surfaces] "Dense mats of floating vegetation can inhibit other native aquatic vegetation, decreasing biodiversity." ... "The dense floating mats of vegetation can negatively affect boating, angling and swimming."

501	Aquatic	y
	Source(s)	**Notes**
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2001. Flora of China. Vol. 6 (Caryophyllaceae through Lardizabalaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Herbs perennial, aquatic." ... "Lakes, ponds, cultivated."
	Roecklein, J.C. & Leung, P. (eds.). (1987). A Profile of Economic Plants. Transaction Publishers, New Brunswick, NJ	"Plants tend to crowd out most other aquatic plants."

502	Grass	n
	Source(s)	**Notes**
	USDA, Agricultural Research Service, National Plant Germplasm System. (2020). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/. [Accessed 30 Mar 2020]	Family: Nelumbonaceae

503	Nitrogen fixing woody plant	n
	Source(s)	**Notes**
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2001. Flora of China. Vol. 6 (Caryophyllaceae through Lardizabalaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Herbs perennial, aquatic." [Nelumbonaceae]

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	**Notes**
	Lim, T.K. (2016). Edible Medicinal And Non-Medicinal Plants. Volume 11, Modified Stems, Roots, Bulbs. Springer, Dordrecht	"Nelumbo nucifera is a perennial, rhizomatous, aquatic herb with the horizontal creeping rhizomes and roots buried in the mud"

Qsn #	Question	Answer
601	**Evidence of substantial reproductive failure in native habitat**	**n**
	Source(s)	**Notes**
	KewScience. (2020). Plants of the World Online - Nelumbo nucifera. http://powo.science.kew.org. [Accessed 30 Mar 2020]	[Habitat loss may contribute to rarity of wild populations] "Although abundant in cultivation, with many different cultivars having been bred over the centuries, local wild populations of sacred lotus in central mainland China have been greatly reduced due to the rapid development of the aquaculture industry."

602	Produces viable seed	y
	Source(s)	**Notes**
	Han, Y. C., Teng, C. Z., Wahiti, G. R., Zhou, M. Q., Hu, Z. L., & Song, Y. C. (2009). Mating system and genetic diversity in natural populations of Nelumbo nucifera (Nelumbonaceae) detected by ISSR markers. Plant Systematics and Evolution, 277(1-2): 13-20	"As an insect-pollinated, aquatic, herbaceous macrophyte, N. nucifera may reproduce by sexual (seeds) and asexual (rhizomes) means."
	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	"Propagation is usually by rhizome division and rarely by seed." ... "Seeds are used by growers trying to create new selections, but seldom by home gardeners. The hard shells make them slow to sprout; filing or piercing the seed coat (scarification) speeds germination."

603	Hybridizes naturally	
	Source(s)	**Notes**
	Kubo, N., Hirai, M., Kaneko, A., Tanaka, D., & Kasumi, K. (2009). Development and characterization of simple sequence repeat (SSR) markers in the water lotus (Nelumbo nucifera). Aquatic Botany, 90(2): 191-194	[Artificial hybrids possible. Natural hybrids might be possible if plants are cultivated together] "Nelumbo contains two species, Nelumbo nucifera Gaertn. (Indian or sacred lotus) and Nelumbo lutea (Willd.) Pers. (American lotus). The former is distributed in Asia and North Australia and the latter is found in North and South America (Borsch and Barthlott, 1996). Although these two species have distinctive characters, such as petal color and leaf size, they also share many similar characteristics and can easily be hybridized."
	Hilty, J. (2020). Wetland Wildflowers of Illinois - Nelumbo nucifera (Sacred Lotus). http://www.illinoiswildflowers.info/. [Accessed 30 Mar 2020]	[Hybrid cultivars possible] "Because American Lotus has pale yellow flowers, it is easy to distinguish from Sacred Lotus. Otherwise, these two species are very similar in appearance. Cultivars that are hybrids of these two species tend to have whitish pink flowers."

Qsn #	Question	Answer
604	**Self-compatible or apomictic**	**y**
	Source(s)	**Notes**
	Schneider, E. L., & Buchanan, J. D. (1980). Morphological studies of the Nymphaeaceae. XI. The floral biology of Nelumbo pentapetala. American Journal of Botany, 67(2): 182-193	"Snigirevskaya (1964) observed flowers on the Volga river and stated that N. nucifera is primarily a facultative self-pollinator. She suggested that bees were actively involved in the pollination process."
	Vogel, S., & Hadacek, F. (2004). Contributions to the functional anatomy and biology of Nelumbo nucifera (Nelumbonaceae) III. An ecological reappraisal of floral organs. Plant Systematics and Evolution, 249(3-4): 173-189	"The stigmata are selfcompatible (Schneider and Buchanan 1980), but autogamy, unless insects mediate it, remains excluded."

605	**Requires specialist pollinators**	**n**
	Source(s)	**Notes**
	Vogel, S., & Hadacek, F. (2004). Contributions to the functional anatomy and biology of Nelumbo nucifera (Nelumbonaceae) III. An ecological reappraisal of floral organs. Plant Systematics and Evolution, 249(3-4): 173-189	[Adaptations for specialized pollinators, but not required] "In summary, we are dealing with a mixed assemblage of insects involved; most of these appear to behave as opportunists and none of them reveal a particular relationship to the elaborate floral design and course of anthesis of this plant. Considering the empirical data, is it, then, justified to follow Bernhardt's (2000) classification of the Nelumbo flower as a generalist?" ... "Nelumbo combines most of the characteristics associated with beetle pollination, such as actinomorphy, polyandry, protogyny, strong aromatic fragrance, thermogenicity, a temporary pollination chamber, pollen shed from anthers and collecting at the perianth floor, and presence of putative food bodies. An uncommon deviation is that anthesis already starts in the morning and continues during the night and the following day."

606	**Reproduction by vegetative fragmentation**	**y**
	Source(s)	**Notes**
	Han, Y. C., Teng, C. Z., Wahiti, G. R., Zhou, M. Q., Hu, Z. L., & Song, Y. C. (2009). Mating system and genetic diversity in natural populations of Nelumbo nucifera (Nelumbonaceae) detected by ISSR markers. Plant Systematics and Evolution, 277(1-2): 13-20	"As an insect-pollinated, aquatic, herbaceous macrophyte, N. nucifera may reproduce by sexual (seeds) and asexual (rhizomes) means."

607	**Minimum generative time (years)**	**1**
	Source(s)	**Notes**
	Missouri Botanical Garden. (2020). Nelumbo nucifera. http://www.missouribotanicalgarden.org. [Accessed 24 Nov 2015]	"Suggested Use: Annual, Water Plant"

701	**Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)**	**n**

Qsn #	Question	Answer
	Source(s)	**Notes**
	Han, Y. C., Teng, C. Z., Wahiti, G. R., Zhou, M. Q., Hu, Z. L., & Song, Y. C. (2009). Mating system and genetic diversity in natural populations of Nelumbo nucifera (Nelumbonaceae) detected by ISSR markers. Plant Systematics and Evolution, 277(1-2): 13-20	"Moreover, seed dispersal is not likely to be very efficient, given the weight of seeds for the species (approximately 1.0 g effectively excluding wind transport) and their lack of dispersal structures."

702	Propagules dispersed intentionally by people	y
	Source(s)	**Notes**
	Roecklein, J.C. & Leung, P. (eds.). (1987). A Profile of Economic Plants. Transaction Publishers, New Brunswick, NJ	"...grown mainly in Japan, China, Hawaii, and India, and to a limited degree in California."
	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	"Lotus has limited usefulness as an ornamental because of its large size and invasive nature."
	WRA Specialist. (2020). Personal Communication	Cultivated as an ornamental and for food

703	Propagules likely to disperse as a produce contaminant	n
	Source(s)	**Notes**
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Dispersed by: Humans, Water, Escapee"
	WRA Specialist. (2020). Personal Communication	No evidence of produce contamination

704	Propagules adapted to wind dispersal	n
	Source(s)	**Notes**
	Han, Y. C., Teng, C. Z., Wahiti, G. R., Zhou, M. Q., Hu, Z. L., & Song, Y. C. (2009). Mating system and genetic diversity in natural populations of Nelumbo nucifera (Nelumbonaceae) detected by ISSR markers. Plant Systematics and Evolution, 277(1-2): 13-20	"Moreover, seed dispersal is not likely to be very efficient, given the weight of seeds for the species (approximately 1.0 g effectively excluding wind transport) and their lack of dispersal structures. The limited seed dispersal contributes to the restricted gene flow and increases the probability that individuals in close physical proximity mated with one another."

705	Propagules water dispersed	y
	Source(s)	**Notes**
	Sharma, O.P. (2009). Plant Taxonomy. Second Edition. Tata McGraw-Hill, New Delhi, India	"Dispersal in this family mainly takes place by water."

Qsn #	Question	Answer
706	**Propagules bird dispersed**	**n**
	Source(s)	**Notes**
	Han, Y. C., Teng, C. Z., Wahiti, G. R., Zhou, M. Q., Hu, Z. L., & Song, Y. C. (2009). Mating system and genetic diversity in natural populations of Nelumbo nucifera (Nelumbonaceae) detected by ISSR markers. Plant Systematics and Evolution, 277(1-2): 13-20	[No evidence] "seed dispersal is not likely to be very efficient, given the weight of seeds for the species (approximately 1.0 g effectively excluding wind transport) and their lack of dispersal structures."

707	**Propagules dispersed by other animals (externally)**	**n**
	Source(s)	**Notes**
	Han, Y. C., Teng, C. Z., Wahiti, G. R., Zhou, M. Q., Hu, Z. L., & Song, Y. C. (2009). Mating system and genetic diversity in natural populations of Nelumbo nucifera (Nelumbonaceae) detected by ISSR markers. Plant Systematics and Evolution, 277(1-2): 13-20	"...seed dispersal is not likely to be very efficient, given the weight of seeds for the species (approximately 1.0 g effectively excluding wind transport) and their lack of dispersal structures."

708	**Propagules survive passage through the gut**	
	Source(s)	**Notes**
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2001. Flora of China. Vol. 6 (Caryophyllaceae through Lardizabalaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[Unknown] "Fruit nutlike, indehiscent. Seeds without endosperm and perisperm"

801	**Prolific seed production (>1000/m2)**	**n**
	Source(s)	**Notes**
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2001. Flora of China. Vol. 6 (Caryophyllaceae through Lardizabalaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Fruit nutlike, indehiscent. Seeds without endosperm and perisperm;" ... "Fruit oblong to ovoid, 1.0–2.0 × 7–15 cm, glabrous; pericarp thick, hardened."
	Rosengarten, Jr., F. (1984). The Book of Edible Nuts. Dover Publications, Mineola, NY	[Relatively large size] "The seeds, about a half inch in length, are whitish after the outer covering has been removed"

802	**Evidence that a persistent propagule bank is formed (>1 yr)**	**y**
	Source(s)	**Notes**
	Shen-Miller, J., Schopf, J. W., Harbottle, G., Cao, R. J., Ouyang, S., Zhou, K. S., Southon, J. R., & Liu, G. H. (2002). Long-living lotus: germination and soil γ-irradiation of centuries-old fruits, and cultivation, growth, and phenotypic abnormalities of offspring. American Journal of Botany, 89(2): 236-247	"Sacred lotus (Nelumbo nucifera) has been cultivated as a crop in Asia for thousands of years. An ;1300-yr-old lotus fruit, recovered from an originally cultivated but now dry lakebed in northeastern China, is the oldest germinated and directly 14C-dated fruit known." ... "The demonstration of exceptional seed longevity in lotus (Nelumbo nucifera) combined with the recent collection of old fruits from the Holocene dry lakebed at Xipaozi present a unique opportunity to study the development of seedlings derived from fruits hundreds of years in age, revealing characteristics of their germination, growth, phenotypic abnormalities, and dormancy."

Qsn #	Question	Answer
803	**Well controlled by herbicides**	**y**
	Source(s)	**Notes**
	Wisconsin Department of Natural Resources. (2019). Sacred Lotus (Nelumbo nucifera). http://dnr.wi.gov/. [Accessed 30 Mar 2020]	"Chemical: Aquatic approved herbicides may control populations. Application of aquatic herbicide will require a permit."
	Aquaplant. (2020). American Lotus - Nelumbo lutea. Texas A&M AgriLife Extension Service, College Station, TX. https://aquaplant.tamu.edu. [Accessed 30 Mar 2020]	[Herbicides effective on related taxon] " The active ingredients that have been successful in treating American Lotus include: 2,4-D (Rated: Excellent) Endothall (Rated: Good) Triclopyr (Rated: Excellent) Glyphosate (Rated: Good) Imazamox (Rated: Good) Fluridone (Rated: Excellent) Penoxsulam (Rated: Good)"

804	**Tolerates, or benefits from, mutilation, cultivation, or fire**	
	Source(s)	**Notes**
	Wisconsin Department of Natural Resources. (2019). Sacred Lotus (Nelumbo nucifera). http://dnr.wi.gov/. [Accessed 30 Mar 2020]	"Mechanical: Very small populations can be controlled by pulling. Physical removal should be completed before flowering and seed set."

805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	
	Source(s)	**Notes**
	WRA Specialist. (2020). Personal Communication	Unknown

Summary of Risk Traits:

High Risk / Undesirable Traits
• Broad climate suitability (>5 hardiness zones)
• Thrives in tropical climates
• Naturalized outside native range (but no evidence from Hawaiian Islands, to date)
• An aquatic weed of lakes, reservoirs, and water bodies, impacting boating, fishing, swimming & potentially competing with native vegetation
• Nelumbo lutea is also regarded as an invasive weed
• Forms dense, smothering mats in aquatic habitats, restricting & outcompeting native species
• Reproduces sexually be seeds & asexually by rhizomes
• Self-compatible
• Able to reproduce in one growing season
• Seeds & rhizomes dispersed by water & intentionally cultivated by people
• Seeds may persist for 100s of years, or longer, forming a persistent seed bank

Low Risk Traits
• May be safe to cultivate in a contained pond or other water feature with minimal risk of natural dispersal
• Unarmed (no spines, thorns or burrs)
• Non-toxic
• Edible to humans & animals
• Ornamental
• Requires full sun
• Certain herbicides may provide effective control