United States Department of Agriculture

United States
Department of
Agriculture

Animal and Plant
Health Inspection
Service

September 24, 2013

Version 1

Weed Risk Assessment for *Xanthoceras sorbifolium* Bunge (Sapindaceae) – Yellowhorn

Colored drawing of *Xanthoceras sorbifolium* (source: Hooker, 1887)

Agency Contact:

Plant Epidemiology and Risk Analysis Laboratory
Center for Plant Health Science and Technology

Plant Protection and Quarantine
Animal and Plant Health Inspection Service
United States Department of Agriculture
1730 Varsity Drive, Suite 300
Raleigh, NC 27606

Introduction Plant Protection and Quarantine (PPQ) regulates noxious weeds under the authority of the Plant Protection Act (7 U.S.C. § 7701-7786, 2000) and the Federal Seed Act (7 U.S.C. § 1581-1610, 1939). A noxious weed is defined as "any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment" (7 U.S.C. § 7701-7786, 2000). We use weed risk assessment (WRA)—specifically, the PPQ WRA model (Koop et al., 2012)—to evaluate the risk potential of plants, including those newly detected in the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

Because the PPQ WRA model is geographically and climatically neutral, it can be used to evaluate the baseline invasive/weed potential of any plant species for the entire United States or for any area within it. As part of this analysis, we use a stochastic simulation to evaluate how much the uncertainty associated with the analysis affects the model outcomes. We also use GIS overlays to evaluate those areas of the United States that may be suitable for the establishment of the plant. For more information on the PPQ WRA process, please refer to the document, *Background information on the PPQ Weed Risk Assessment*, which is available upon request.

***Xanthoceras sorbifolium* Bunge. – Yellowhorn**

Species Information

Family: Sapindaceae

Synonyms: None. It is often mistakenly referred to as *Xanthoceras sorbifolia* in the literature (NRCS, 2013).

Initiation: On February 21, 2012, Marilyn Jordan with The Nature Conservancy of New York requested we assess this species because it may be cultivated in the United States as a biofuel (Jordan, 2012).

Foreign distribution: This species is native to northern China and South Korea (MBG, 2013; NGRP, 2013). It has been introduced to Australia, France, Hungary, and the United Kingdom (Botond and Zoltan, 2004; Hooker, 1887; Randall, 2007), but we found no evidence it has become naturalized in these countries.

U.S. distribution and status: Other than one record in The North American Plant Atlas (Kartesz, 2013), we found no evidence that this species is escaped or naturalized in the United States (e.g., eFloras, 2013; WTU, 2013). The record in the Plant Atlas is somewhat misleading as it does not reflect a naturalized or casual occurrence; rather, it is a single mature tree that is possibly a relic from cultivation at a former home site (Old, 2013). *Xanthoceras sorbifolium* has been cultivated in the United States since at least 1915 (Anonymous, 1915; Bailey and Bailey, 1930), most likely for ornamental reasons. Although some nurseries sell it (e.g., Anonymous, 2013), it is rarely found in commerce (Anonymous, 2013; Dirr, 1998).

WRA area[1]: Entire United States, including territories.

[1] "WRA area" is the area in relation to which the weed risk assessment is conducted [definition modified from that for "PRA area" (IPPC, 2012).

1. *Xanthoceras sorbifolium* analysis

Establishment/Spread Potential We found little evidence that *Xanthoceras sorbifolium* is capable of becoming invasive. This species is slow growing (Anonymous, 1915; Dave's Garden, 2013), has low fertility (Hou et al., 2009; Yao et al., 2013; Zhou and Liu, 2012), is self-incompatible (Zhou and Liu, 2012), and has limited dispersal potential (Appendix. A). Except for two questionable records indicating it is a casual alien (Botond and Zoltan, 2004; Kartesz, 2013), we found no evidence that it has escaped or naturalized beyond its native range. This species was introduced into Europe in the 1860s for cultivation (Hooker, 1887), and is reported only as a casual alien in one area (Botond and Zoltan, 2004). We had slightly above average uncertainty.
Risk score = -6 Uncertainty index = 0.24

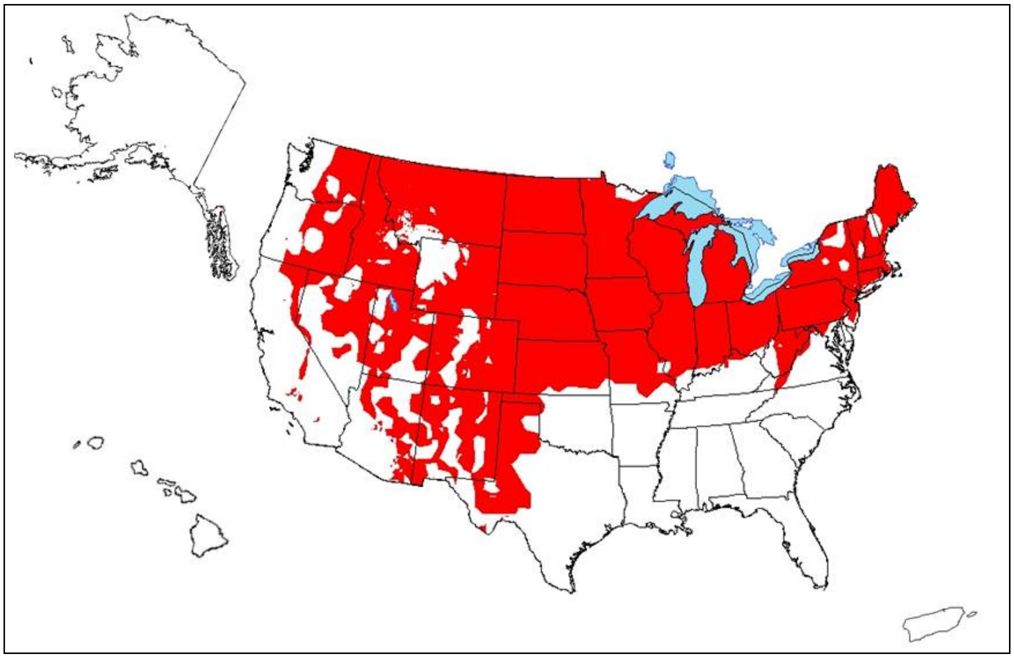
Impact Potential We found no evidence of impacts caused by this species. Because it has been in cultivation since at least the 1860s (Anonymous, 1915; Bailey and Bailey, 1930; Hooker, 1887), our uncertainty was low.
Risk score = 1 Uncertainty index = 0.06

Geographic Potential Based on three climatic variables, we estimate that about 48 percent of the United States is suitable for the establishment of *X. sorbifolium* (Fig. 1). This predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence. The map for *X. sorbifolium* represents the joint distribution of Plant Hardiness Zones 4-8, areas with 10-60 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, and humid continental cool and warm summers. We had moderate to somewhat high uncertainty with this analysis because only two geo-referenced point occurrences exist for this species in its native range (GBIF, 2013). Most of our evaluation was based on regional occurrences in northern provinces in China and in South Korea (MBG, 2013; NGRP, 2013; Zhengyi et al., 2013).

Xanthoceras sorbifolium grows in arid and semi-arid temperate regions (Zhou and Liu, 2012) and occurs in forest and forest-prairie habitats (Kang et al., 2010). Some provinces in northern China have dry (0-10 inches annual precipitation), desert climates. We assumed *X. sorbifolium* does not naturally occur in these areas because this species does not appear to possess morphological adaptations (Zhengyi et al., 2013) for living in these extreme conditions. The U.S. area estimated in our analysis (Fig. 1) likely represents a conservative estimate as it only uses three climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish.

Entry Potential We did not assess *X. sorbifolium*'s entry potential because this species is already present in the United States (Anonymous, 1915, 2013; Bailey and Bailey, 1930).

Figure 1. Predicted distribution of *Xanthoceras sorbifolium* in the United States. Map insets for Alaska, Hawaii, and Puerto Rico are not to scale.



2. Results and Conclusion

Model Probabilities: P(Major Invader) = 0.7%
P(Minor Invader) = 18.3%
P(Non-Invader) = 81.0%

Risk Result = Low Risk

Secondary Screening = Not Applicable

Figure 2. *Xanthoceras sorbifolium* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

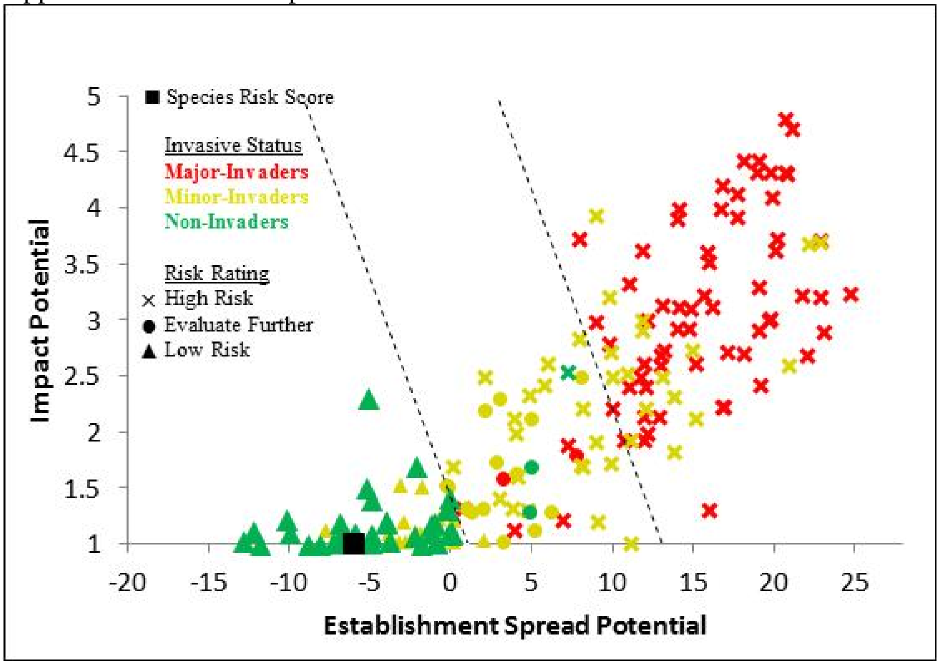
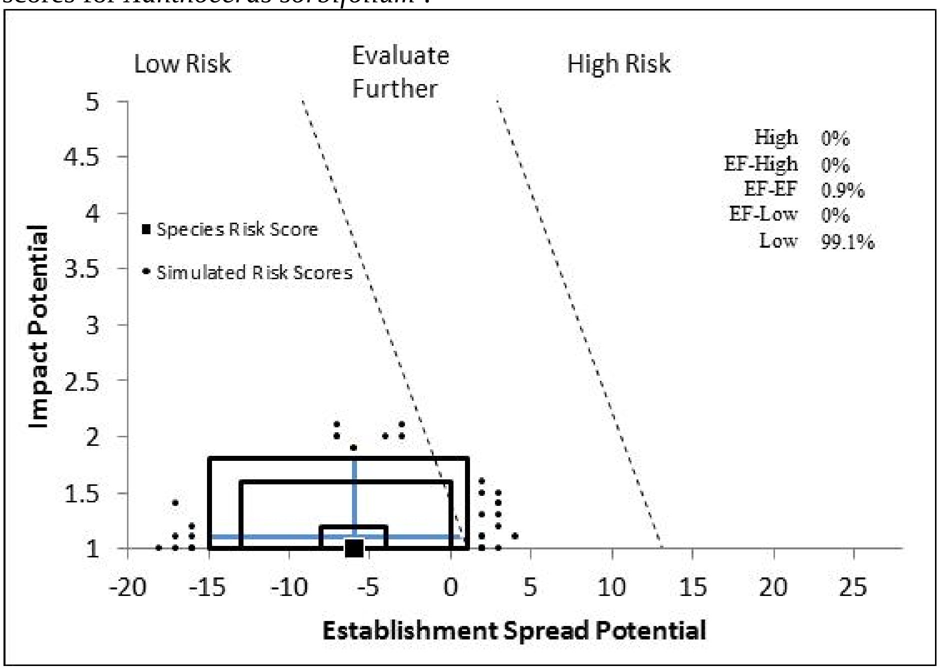


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Xanthoceras sorbifolium*[a].



[a] The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *X. sorbifolium* is Low Risk (Fig. 2). Despite the limited information available on this species' biology, we are confident in our result (Fig. 3) because this species has been cultivated for over a hundred years (Anonymous, 1915; Hooker, 1887). *Xanthoceras sorbifolium* is cultivated in China for its seeds (Liu et al., 2010)., and is a potential biofuel species because of their rich oil content (Li et al., 2012; Li et al., 2013; Park et al., 2012; Yao et al., 2013). Some argue this species is not a good candidate for biodiesel production because of the low rates of fruit production (e.g., Hou et al., 2009).

4. Literature Cited

7 U.S.C. § 1581-1610. 1939. The Federal Seed Act, Title 7 United States Code § 1581-1610.

7 U.S.C. § 7701-7786. 2000. Plant Protection Act, Title 7 United States Code § 7701-7786.

Anonymous. 1915. Flowering plants for St. Louis. Missouri Botanical Garden Bulletin 3(10):126-134.

Anonymous. 2013. *Xanthoceras sorbifolium*. Digging Dog Nursery. Last accessed August 14, 2013, http://www.diggingdog.com/pages2/plantpages.php/s-0721.

Bailey, L. H., and E. Z. Bailey. 1930. Hortus: A Concise Dictionary of Gardening, General Horticulture and Cultivated Plants in North America. The MacMillan Company, New York. 352 pp.

Botond, M., and B.-D. Zoltan (eds.). 2004. Biologiai Invaziok Magyarorszagon: Ozonnovenyek [Biological Invasions in Hungary: Invasive Plants]. TermészetBÚVÁR Alapítvány Kiadó, Budapest. 409 pp.

Chai, C. S., J. Lu, G. J. Cai, S. Y. Wang, J. L. Qi, Z. T. Wang, and R. Xue. 2013. Fruit phenotypic diversity and variation of *Xanthoceras sorbifolia* artificial population [Abstract]. Forest Research [Beijing] 26(2):181-191.

Dave's Garden. 2013. Plant files database. Dave's Garden. http://davesgarden.com/guides/pf/go/1764/. (Archived at PERAL).

Dirr, M. A. 1998. Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses (5th ed.). Stipes Publishing, Champaign, IL. 1187 pp.

eFloras. 2013. Electronic Floras, online database. Missouri Botanical Garden, St. Louis, MO and Harvard University Herbaria, Cambridge, MA. http://www.efloras.org. (Archived at PERAL).

GBIF. 2013. GBIF, Online Database. Global Biodiversity Information Facility (GBIF). http://data.gbif.org/welcome.htm. (Archived at PERAL).

Guo, Y., W. Zhang, J. He, J. Zhou, and H. Yu. 2012. Effects of water stress and seed mass on germination and antioxidative enzymes of *Xanthoceras sorbifolia*. African Journal of Biotechnology 11(18):4187-4195.

Harrington, M. G., K. J. Edwards, S. A. Johnson, M. W. Chase, and P. A. Gadek. 2005. Phylogenetic inference in sapindaceae sensu lato using plastid matK and rbcL DNA sequences. Systematic Botany 30(2):366-382.

Heap, I. 2013. The international survey of herbicide resistant weeds. Weed Science Society of America. www.weedscience.com. (Archived at PERAL).

Heide-Jorgensen, H. S. 2008. Parasitic Flowering Plants. Brill, Leiden, The Netherlands. 438 pp.

Hooker, J. D., Sir. 1887. *Xanthoceras sorbifolia*: Native of North China. Curtis's Botanical Magazine 113(Series 3):tab. 6923.

Hou, Y. K., S. Y. Liu, L. Huang, and H. J. Zhou. 2009. Selection and evaluation of Bio-diesel tree species in China [Abstract]. Forest Research 22(1):7-13.

IPPC. 2012. International Standards for Phytosanitary Measures No. 5: Glossary of Phytosanitary Terms. Food and Agriculture Organization of the United Nations, Secretariat of the International Plant Protection Convention (IPPC), Rome, Italy.

Jordan, M. 2012. Weed risk assessment: More species for PPQ WRA? Personal communication to A. Koop on February 21, 2012, from Marilyn Jordan, Senior Conservation Scientist, The Nature Conservancy on Long Island.

Kang, Y., B. Kang, J. Liu, W. Li, and Z. Ji. 2010. Structure and species diversity of *Xanthoceras sorbifolia* community in the Loess Plateau of North Shaanxi [Abstract]. Shengtai Xuebao/ Acta Ecologica Sinica 30(16):4328-4339.

Kartesz, J. 2013. The Biota of North America Program (BONAP). North American Plant Atlas. http://www.bonap.org/MapSwitchboard.html. (Archived at PERAL).

Koop, A., L. Fowler, L. Newton, and B. Caton. 2012. Development and validation of a weed screening tool for the United States. Biological Invasions 14(2):273-294.

Li, J., Y.-J. Fu, X.-J. Qu, W. Wang, M. Luo, C.-J. Zhao, and Y.-G. Zu. 2012. Biodiesel production from yellow horn (*Xanthoceras sorbifolia* Bunge.) seed oil using ion exchange resin as heterogeneous catalyst. Bioresource Technology 108(0):112-118.

Li, J., Y. G. Zu, M. Luo, C. B. Gu, C. J. Zhao, T. Efferth, and Y. J. Fu. 2013. Aqueous enzymatic process assisted by microwave extraction of oil from yellow horn (*Xanthoceras sorbifolia* Bunge.) seed kernels and its quality evaluation. Food Chemistry 138(4):2152-2158.

Liu, B., L. H. Wang, L. M. Yin, and Y. X. Mao. 2010. Seasonal variation and resorption characteristics of leaf N, P, and K in two aged *Xanthoceras sorbifolia* plantations [Abstract]. Chinese Journal of Ecology 29(7):1270-1276.

Ma, L. P., L. H. Wang, L. M. Yin, B. Liu, and W. Chen. 2008. Biology and phenology of *Xanthoceras sorbifolia* in Wudan area [Abstract]. Chinese Journal of Applied Ecology 19(12):2583-2587.

Mabberley, D. J. 2008. Mabberley's Plant-Book: A Portable Dictionary of Plants, their Classification and Uses (3rd edition). Cambridge University Press, New York. 1021 pp.

MBG. 2013. Tropicos Database. Missouri Botanical Garden (MBG). http://www.tropicos.org/Home.aspx. (Archived at PERAL).

NGRP. 2013. Germplasm Resources Information Network (GRIN). United States Department of Agriculture, Agricultural Research Service, National Genetic Resources Program (NGRP). http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl?language=en. (Archived at PERAL).

Nickrent, D. 2009. Parasitic plant classification. Southern Illinois University Carbondale, Carbondale, IL. Last accessed June 12, 2009, http://www.parasiticplants.siu.edu/ListParasites.html.

NRCS. 2013. The PLANTS Database. United States Department of Agriculture, Natural Resources Conservation Service (NRCS), The National Plant Data Center. http://plants.usda.gov/cgi_bin/. (Archived at PERAL).

Old, R. 2013. Your record of *Xanthoceras sorbifolium* Personal communication to

A. Koop on September 6, 2013, from Richard Old (weed scientist).

Park, Y. H., K. Y. Lee, S. Y. Hong, H. Y. Kim, N. K. Heo, and K. H. Kim. 2012. A study on physiochemical characteristics of *Xanthoceras sorbifolia* seeds oil [Abstract]. Journal of the Korean Society of Food Science and Nutrition 41(12):1747-1752.

Randall, J. M. 2007. The Introduced Flora of Australia and its Weed Status. CRC for Australian Weed Management, Department of Agriculture and Food, Western Australia, Australia. 528 pp.

Stapanian, M. A., and C. C. Smith. 1986. How Fox Squirrels Influence the Invasion of Prairies by Nut-Bearing Trees. Journal of Mammalogy 67(2):326-332.

Wang, C., D. M. Wang, Y. H. Li, Y. Zhang, and W. H. Lai. 2013. Introduction experiment of bio-energy plant *Xanthoceras sorbifolia* in the gully region of the loess tableland residue in Shanxi Province, northern China [Abstract]. Beijing Linye Daxue Xuebao/Journal of Beijing Forestry University 35(3):90-96.

WTU. 2013. Herbarium Database. The University of Washington (WTU). http://www.burkemuseum.org/herbarium. (Archived at PERAL).

Yao, Z. Y., J. H. Qi, and L. M. Yin. 2013. Biodiesel production from *Xanthoceras sorbifolia* in China: Opportunities and challenges. Renewable and Sustainable Energy Reviews 24:57-65.

Zhengyi, W., P. H. Raven, and H. Deyuan. 2013. Flora of China. Missouri Botanical Garden Press. http://flora.huh.harvard.edu/china/. (Archived at PERAL).

Zhou, Q. Y., and G. S. Liu. 2012. The embryology of *Xanthoceras* and its phylogenetic implications. Plant Systematics and Evolution 298(2):457-468.

Zhou, Y., S. Gao, X. Zhang, H. Gao, Q. Hu, Y. Song, and Y. Jiao. 2012. Morphology and biochemical characteristics of pistils in the staminate flowers of yellow horn during selective abortion. Australian Journal of Botany 60(2):143-153.

Appendix A. Weed risk assessment for *Xanthoceras sorbifolium* Bunge (Sapindaceae). The following information came from the original risk assessment, which is available upon request (full responses and all guidance). We modified the information to fit on the page.

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 (Status/invasiveness outside its native range)	d - high	0	Native to northern China and South Korea (MBG, 2013; NGRP, 2013). Introduced to Australia with no evidence of naturalizing (Randall, 2007). Introduced to the United Kingdom in the 1860's (Hooker, 1887) without evidence of escape. "Occasionally appearing" in Hungary (Botond and Zoltan, 2004), but we found no other evidence supporting this. *Xanthoceras sorbifolium* is listed as an escaped or naturalized exotic in Asotin County in Washington State (Kartesz, 2013), but this record is based upon a mature tree that is possibly a relic from cultivation at a former home site (Old, 2013). During our literature review, we found no other evidence that this species is escaped or naturalized in the United States (e.g., eFloras, 2013; WTU, 2013). We answered d (a casual) based on the report from Hungary, but we are uncertain about this species' status because we found no supporting evidence. Alternate answers for the Monte Carlo simulation were "a" and "b."
ES-2 (Is the species highly domesticated)	n - negl	0	This species is cultivated (Liu et al., 2010; NGRP, 2013). Provenance trials are being conducted in China to select genotypes best suited to grow in certain regions (Wang et al., 2013). Variation and potential heredity of fruit and seed characters are also being evaluated (Chai et al., 2013). However, we found no evidence of breeding to reduce traits associated with weed potential.
ES-3 (Weedy congeners)	n - low	0	*Xanthoceras sorbifolium* is the only species in this genus (Mabberley, 2008). This monotypic genus is not closely related to any other species, and is typically considered a sister group to all other Sapindaceae, Aceraceae, and Hippocastanaceae (Harrington et al., 2005; Zhou and Liu, 2012). This precludes comparison to other taxa.
ES-4 (Shade tolerant at some stage of its life cycle)	n - low	0	We found no evidence. This species should be grown in full sun (Dirr, 1998). Recommended for full sun and will tolerate partial shade (Anonymous, 2013).
ES-5 (Climbing or smothering growth form)	n - negl	0	A small to medium sized tree to 10 meters tall (Zhou and Liu, 2012).
ES-6 (Forms dense thickets)	n - mod	0	We found no evidence.
ES-7 (Aquatic)	n - negl	0	Not an aquatic, rather a shrub or small tree two to five meters tall (Zhengyi et al., 2013; Zhou and Liu, 2012).
ES-8 (Grass)	n - negl	0	Species is not a grass; rather it is in the Sapindaceae family (Zhengyi et al., 2013; Zhou and Liu, 2012).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	We found no evidence. Species is in the Sapindaceae (Zhengyi et al., 2013), which is not known to contain nitrogen-fixing species.
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Produces and propagated by seeds (Anonymous, 2013; Bailey and Bailey, 1930; Guo et al., 2012).
ES-11 (Self-compatible or apomictic)	n - low	-1	Male flowers and bisexual flowers on the same plant but not on the same inflorescence (Zhengyi et al., 2013; Zhou et al.,

Question ID	Answer - Uncertainty	Score	Notes (and references)
			2012). Produces male flowers and hermaphrodite flowers (Zhou and Liu, 2012). However, the bisexual flowers are functionally female as 95 percent of the anthers do not dehisce their mature pollen (Zhou and Liu, 2012; Zhou et al., 2012). In a pollination experiment, fruit developing from self-pollination wilted and dehisced after 7-14 days, due to late-acting ovarian self-incompatibility (Zhou and Liu, 2012). Although we consider this evidence as sufficient for negligible uncertainty, because there is a report of "self set" fruit in garden (Dave's Garden, 2013), we used low uncertainty.
ES-12 (Requires special pollinators)	n - mod	0	"Flowers had nectar in the disk. Although bees and flies occasionally visited the flowers, wind was the primary pollination vector" (Zhou and Liu, 2012). It seems odd that a species with showy flowers and that produces nectar would be primarily pollinated by wind. In the United States where *X. sorbifolium* has been introduced for cultivation, it is setting fruit (Dave's Garden, 2013). Given that the species may be pollinated by wind or perhaps bees, and that it is setting seed outside of its native range without any reports of a specialized pollinator, it seems unlikely that it requires specialized pollinators. Consequently we answered no with moderate uncertainty.
ES-13 (Minimum generation time)	d - high	-1	We found no definitive evidence other than that this species is slow growing (Anonymous, 1915; Dave's Garden, 2013), and that trees flower when they are small (Dave's Garden, 2013). Given these anecdotal reports and that this species is a small to medium sized tree, we answered "d" but with high uncertainty. Alternate answers for the Monte Carlo simulation were both "c."
ES-14 (Prolific reproduction)	n - low	-1	Capsules contain 3 locules, each with several seeds (Zhengyi et al., 2013). Occasionally seedlings are found under parent trees (Anonymous, 2013). Few fruits are set because the number of staminate flowers is much greater than hermaphrodite flowers (Zhou et al., 2012). Low fruit set (Hou et al., 2009; Yao et al., 2013). In one study, a small fraction (5 percent) of cross-pollinated fruit developed normally and dehisced after 75 days, producing 15-25 large black seeds (Zhou and Liu, 2012). 73 percent and 94 percent of flowers and fruit drop prematurely (Ma et al., 2008). Although we have no quantitative estimates of seed production per square meter, we are confident it is less than 1000 per square meter.
ES-15 (Propagules likely to be dispersed unintentionally by people)	n - mod	-1	We found no evidence. Furthermore, given the size of the fruit and seeds (Dirr, 1998), this seems unlikely.
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - low	-1	We found no evidence. It does not seem likely that fruit or seeds from this large-fruited species (Dirr, 1998) would contaminate a commodity pathway.
ES-17 (Number of natural dispersal vectors)	1	-2	Fruit and seed description for questions ES-17a through ES-17e: Fruit is a thick-walled capsule 2 to 3 (4) inches in diameter (Dirr, 1998). Fruit a capsule about 1.8 cm (Zhengyi et al., 2013). Fruit contain 3 cells, each with several pea-sized seeds (Dirr, 1998). Seeds without an aril (Zhou and Liu, 2012).
ES-17a (Wind dispersal)	n - negl		We found no evidence. The large fruit and seeds of this species

Question ID	Answer - Uncertainty	Score	Notes (and references)
			(Dirr, 1998; Zhengyi et al., 2013) are not adapted for wind dispersal.
ES-17b (Water dispersal)	n - low		We found no evidence. Furthermore, this species grows in forest and forest-prairie habitats in arid and semi-arid temperate regions (Kang et al., 2010; Zhou and Liu, 2012) and does not appear to be restricted to riparian habitats.
ES-17c (Bird dispersal)	n - negl		We found no evidence. The fruit and seeds of this species are unlikely to be dispersed by birds given their size and a lack adaptations to attract birds (Dirr, 1998; Zhengyi et al., 2013).
ES-17d (Animal external dispersal)	y - high		One gardener commented that they thought squirrels may be taking the capsules (Dave's Garden, 2013). Given that squirrels disperse other species of trees with similarly sized nuts (Stapanian and Smith, 1986), answering yes but with high uncertainty.
ES-17e (Animal internal dispersal)	n - low		We found no evidence and unlikely given that the large seeds would be damaged during mastication.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	? - max	0	Unknown.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	? - max	0	Unknown.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	We found no evidence and not listed by Heap (2013). Given that this species is not a weed and does not occur in environments where herbicides are heavily used (e.g., row crops), it is unlikely to have developed herbicide resistance.
ES-21 (Number of cold hardiness zones suitable for its survival)	5	0	
ES-22 (Number of climate types suitable for its survival)	3	0	
ES-23 (Number of precipitation bands suitable for its survival)	5	0	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - mod	0	We found no evidence.
Imp-G2 (Parasitic)	n - negl	0	Species is in the Sapindaceae (Zhengyi et al., 2013), which is not known to contain any parasitic plants (Heide-Jorgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	n - mod	0	No evidence found. Using moderate uncertainty for some questions in this subsection because there isn't much ecological information available on this species.
Imp-N2 (Change community structure)	n - mod	0	We found no evidence.
Imp-N3 (Change community composition)	n - mod	0	We found no evidence.
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	n - low	0	
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	n - low	0	We found no evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-N6 (Weed status in natural systems)	a - low	0	We found no evidence that this species is considered a weed. Alternate answers for the Monte Carlo simulation were both "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	n - low	0	We found no evidence. Using low uncertainty for the questions in this subsection because this species' behavior in cultivation is somewhat known.
Imp-A2 (Changes or limits recreational use of an area)	n - low	0	We found no evidence.
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - low	0	We found no evidence.
Imp-A4 (Weed status in anthropogenic systems)	a - low	0	No evidence found that this species is considered a weed. Alternate answers for the Monte Carlo simulation were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	n - low	0	We found no evidence. Using low uncertainty for the questions in this subsection because this species seems unlikely to become a production system weed.
Imp-P2 (Lowers commodity value)	n - low	0	We found no evidence.
Imp-P3 (Is it likely to impact trade)	n - low	0	We found no evidence.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - low	0	We found no evidence.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - low	0	We found no evidence.
Imp-P6 (Weed status in production systems)	a - low	0	We found no evidence that this species is considered a weed. Alternate answers for the Monte Carlo simulation were both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced, point references obtained from the Global Biodiversity Information Facility (GBIF, 2013).
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence.
Geo-Z2 (Zone 2)	n - low	N/A	We found no evidence.
Geo-Z3 (Zone 3)	n - high	N/A	Hardy to zone (3)4 to 6(7) (Dirr, 1998). Because we found no other evidence and because plants may be grown in sheltered locations, we answered no with high uncertainty.
Geo-Z4 (Zone 4)	y - mod	N/A	Growing well in Blair Nebraska where winter lows reach -25 to -30 °F (Dirr, 1998). Hardy to zone (3)4 to 6(7) (Dirr, 1998). Blooms in Zone 4 in South Dakota but experiences winter die-back (Anonymous, 2013).
Geo-Z5 (Zone 5)	y - low	N/A	Regional occurrence in China (e.g., Nei Mongol, Hebei; NGRP, 2013; Zhengyi et al., 2013). Hardy to zone (3)4 to 6(7) ({Dirr, 1998 #8256}).
Geo-Z6 (Zone 6)	y - negl	N/A	Two points in China (NGRP, 2013). Regional occurrence in China (e.g., Shaanxi, Ningxia;NGRP, 2013; Zhengyi et al., 2013). Hardy to this zone ({Bailey, 1976 #6819}). Hardy to

Question ID	Answer - Uncertainty	Score	Notes (and references)
			zone (3)4 to 6(7) (Dirr, 1998).
Geo-Z7 (Zone 7)	y - low	N/A	Regional occurrence in China (e.g., Shaanxi, Hebei; NGRP, 2013; Zhengyi et al., 2013). Hardy to zone (3)4 to 6(7) ({Dirr, 1998 #8256}).
Geo-Z8 (Zone 8)	y - high	N/A	Regional occurrence in China (e.g., Henan; NGRP, 2013; Zhengyi et al., 2013).
Geo-Z9 (Zone 9)	n - high	N/A	We found no evidence.
Geo-Z10 (Zone 10)	n - negl	N/A	We found no evidence.
Geo-Z11 (Zone 11)	n - negl	N/A	We found no evidence.
Geo-Z12 (Zone 12)	n - negl	N/A	We found no evidence.
Geo-Z13 (Zone 13)	n - negl	N/A	We found no evidence.
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	We found no evidence.
Geo-C2 (Tropical savanna)	n - negl	N/A	We found no evidence.
Geo-C3 (Steppe)	y - low	N/A	Regional occurrence in China (e.g., Nei Mongol, Ningxia; NGRP, 2013; Zhengyi et al., 2013).
Geo-C4 (Desert)	n - high	N/A	Regional occurrence in China (e.g., Nei Mongol, Ningxia, Gansu; NGRP, 2013; Zhengyi et al., 2013).
Geo-C5 (Mediterranean)	n - low	N/A	We found no evidence.
Geo-C6 (Humid subtropical)	n - mod	N/A	This species occurs in Henan Province China (NGRP, 2013; Zhengyi et al., 2013).
Geo-C7 (Marine west coast)	n - low	N/A	We found no evidence.
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	Two points in China (NGRP, 2013). Regional occurrence in China (e.g., Shaanxi, Ningxia; NGRP, 2013; Zhengyi et al., 2013).
Geo-C9 (Humid cont. cool sum.)	y - mod	N/A	Regional occurrence in China (e.g., Gansu, Ningxia, Shaanxi; NGRP, 2013; Zhengyi et al., 2013).
Geo-C10 (Subarctic)	n - high	N/A	We found no evidence.
Geo-C11 (Tundra)	n - low	N/A	We found no evidence.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	n - high	N/A	Regional occurrence in China (e.g., Nei Mongol, Ningxia, Gansu; NGRP, 2013; Zhengyi et al., 2013).
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	One point in China (NGRP, 2013). Regional occurrence in China (e.g., Hebei, Shaanxi; NGRP, 2013; Zhengyi et al., 2013).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	One point in China (NGRP, 2013). Regional occurrence in China (e.g., Shandong, Henan, Shanxi; NGRP, 2013; Zhengyi et al., 2013).
Geo-R4 (30-40 inches; 76-102 cm)	y - low	N/A	Regional occurrence in China (e.g., Gansu, Shanxi, Shandong; NGRP, 2013; Zhengyi et al., 2013).
Geo-R5 (40-50 inches; 102-127 cm)	y - low	N/A	Regional occurrence in South Korea (MBG, 2013).
Geo-R6 (50-60 inches; 127-152 cm)	y - low	N/A	Regional occurrence in South Korea (MBG, 2013).
Geo-R7 (60-70 inches; 152-178 cm)	n - high	N/A	We found no evidence.
Geo-R8 (70-80 inches; 178-203 cm)	n - low	N/A	We found no evidence.
Geo-R9 (80-90 inches; 203-229 cm)	n - negl	N/A	We found no evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R10 (90-100 inches; 229-254 cm)	n - negl	N/A	We found no evidence.
Geo-R11 (100+ inches; 254+ cm))	n - negl	N/A	We found no evidence.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	*Xanthoceras sorbifolium* has been cultivated in the United States since at least 1915 (Anonymous, 1915; Bailey and Bailey, 1930). Although some nurseries carry it (e.g., Anonymous, 2013), it is rarely found in commerce (Anonymous, 2013; Dirr, 1998).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	This species is valued for the oil content of its seeds (Li et al., 2013).
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	-	N/A	
Ent-4b (Contaminant of plant propagative material (except seeds))	-	N/A	
Ent-4c (Contaminant of seeds for planting)	-	N/A	
Ent-4d (Contaminant of ballast water)	-	N/A	
Ent-4e (Contaminant of aquarium plants or other aquarium products)	-	N/A	
Ent-4f (Contaminant of landscape products)	-	N/A	
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	-	N/A	
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	-	N/A	
Ent-4i (Contaminant of some other pathway)	-	N/A	
Ent-5 (Likely to enter through natural dispersal)	-	N/A	