NAME OF SPECIES: *Ailanthus altissima*	
Synonyms: *Ailanthus glandulosa Desf.*	
Common Name: *Tree of Heaven, Chinese Sumac, Stinking Sumac, Copal Tree, Varnish Tree, Paradise Tree*	
A. CURRENT STATUS AND DISTRIBUTION	
I. In Wisconsin?	1. YES ☒ NO ☐
	2. Abundance: Mostly found in urban areas in SE Wisconsin
	3. Geographic Range: Vouchered in the counties of Brown, Walworth, Milwaukee, Racine, Kenosha, Grant, Door, Jefferson. Present in additional counties including Dane.
	4. Habitat Invaded: Urban areas: alleys, sidewalks, parking lots, streets. Rural areas: fields, roadsides, fences, woodland edges, forest openings. Currently mostly limited to disturbed and urban areas in WI. Disturbed Areas ☒ Undisturbed Areas ☒
	5. Historical Status and Rate of Spread in Wisconsin: Earliest collection by county: Brown: 1978, Walworth: 1987, Milwaukee: 1940, Racine: 1975, Kenosha: 1975
	6. Proportion of potential range occupied: Currently occupies a very small area of its potential habitat.
II. Invasive in Similar Climate Zones	1. YES ☒ NO ☐ Where (include trends): Naturalized in most states, including: CO, CT, IA, IL, IN, MA, ME, MI, MO, NJ, NY, OH, OR, PA, RI, WA, Australia, New Zealand, Canada, Europe. Becoming very invasive in forested areas in eastern and midwestern states in recent years.
III. Invasive in Similar Habitat Types	1. Upland ☒ Wetland ☐ Dune ☐ Prairie ☐ Aquatic ☐ Forest ☒ Grassland ☒ Bog ☐ Fen ☐ Swamp ☐ Marsh ☐ Lake ☐ Stream ☐ Other: Seedlings often sprout in recently planted fields and thickets formed in rocky, untillable areas. Usually follows disturbed areas, but recently has also spread to undisturbed areas such as forests and woodlands. Seedlings are shade tolerant enough to persist in the understory of undisturbed forests, but quickly take advantage of any breaks in the canopy and fill forest gaps.
IV. Habitat Effected	1. Soil types favored (e.g. sand, silt, clay, or combinations thereof, pH): Prefers loamy, moist soils, but can tolerate a wide range of textures, stoniness, and pH. Most commonly found in soil orders of ultisols, inceptisols, entisols. Is able to tolerate soils of pH <4.1, soluble salt concentrations up to 0.25 mmhos/cm, and phosphorus levels as low as 1.8 ppm.
	2. Conservation significance of threatened habitats: Forest habitats are very important.
V. Native Habitat	1. List countries and native habitat types: China–temperate climate
VI. Legal Classification	1. Listed by government entities? CT: invasive, banned; MA: Prohibited; NH: Prohibited invasive species; VT: Class B noxious weed
	2. Illegal to sell? YES ☒ NO ☐ Notes: Illegal in some New England states.

B. ESTABLISHMENT POTENTIAL AND LIFE HISTORY TRAITS	
I. Life History	1. Type of plant: Annual ☐ Biennial ☐ Monocarpic Perennial ☐ Herbaceous Perennial ☐ Vine ☐ Shrub ☐ Tree ☒
	2. Time to Maturity: Usually 2 years, but precocious flowering is not unusual and sometimes occurs only 6 weeks after germination.
	3. Length of Seed Viability: 60 days to 1 yr
	4. Methods of Reproduction: Asexual ☒ Sexual ☒ Please note abundance of propagules and and other important information: A dioecious tree (14). Fruits, called samaras, are papery, twisted, winged. Fruits occur in large clusters from September to October and stay on tree through next winter. Trees flower in the spring. Individual trees can produces as many as 325,000 seeds in one year. Established trees also produce numerous suckers from the roots and resprout vigorously from cut stumps and root fragments.
	5. Hybridization potential: Non-invasive male clones have been selected including the cultivar "Metro" (14). In the two centuries since its introduction into North America, ailanthus has probably become differentiated into genetically different subpopulations based on seed traits. Seed characteristics of ailanthus have been identified as traits that differentiate varieties and geographical strains. Ailanthus with bright red samaras compared to the more common greenish yellow has been named Ailanthus altissima var. erythrocarpa (Carr.) Rehd. A study of 11 seed sources from California and Eastern States found that seed width and weight were correlated with latitude (6). Northern sources have wider, heavier seed than the more southern sources." (USDA Forest Service–Northeastern Area–Ailanthus http://www.na.fs.fed.us/spfo/pubs/silvics_manual/Volume_2/ailanthus/altissima.htm)
II. Climate	1. Climate restrictions: Very adaptive to different climates. Can survive in temperate to subtropical and humid to arid. Can also survive ranging wetness conditions from 360 -610 mm rain to as much as 2290 mm annually. Young trees sensitive to extreme colds, but trees 6+ have survived temps as low as -33 degrees Celsius.
	2. Effects of potential climate change: May increase potential range.
III. Dispersal Potential	1. Pathways - Please check all that apply: Intentional: Ornamental ☒ Forage/Erosion control ☒ Medicine/Food: Other: fuel, crafts, turnery, pulp Unintentional: Bird ☐ Animal ☐ Vehicles/Human ☐ Wind ☒ Water ☒ Other:
	2. Distinguishing characteristics that aid in its survival and/or inhibit its control: Grows rapidly (1m/yr for at least the first 4 yrs), even in poor soil. Grows up to 80 ft (24m), diameter of 2 ft (0.6 m). Pioneer species that crowds out other native tree species. Highly resistant to insect predation and suffers little from disease. Strong and offensive odor. Aggressive root system. Abundant seed production, high seed germination rate, and vegetative reproduction. Drought hardy. Persistent root system.

IV. Ability to go Undetected	1. HIGH ☐ MEDIUM ☒ LOW ☐
C. DAMAGE POTENTIAL	
I. Competitive Ability	1. Presence of Natural Enemies: In its native range, 32 anthropods and 13 fungi have been identified as natural enemies to the tree. For a complete list, visithttp://www.invasive.org/weeds/asian/ailanthus.pdf
	2. Competition with native species: Previously established trees may provide root competition for Ailanthus. It can spread clonally creating dense thickets that can out-compete native trees (16). It has been found to compete successfully with native trees in canopy gaps in an old-growth forest in a New York study (21). The initial entry probably came from the following "Although ailanthus may suffer from root competition by other trees already established in an area (Cozzo 1972), usually it competes successfully with other plants (Cozzo 1972, Hu 1979)" (3).
	3. Rate of Spread: HIGH(1-3 yrs) ☐ MEDIUM (4-6 yrs) ☒ LOW (7-10 yrs) ☐ Notes: One study from Sonoma University indicates a max spread in a continuous population at 40 m/yr and >200 m/yr discontinuous A study by Hutchinson et al. found *Ailanthus* trees present, but not abundant, on a study site in Ohio prior to thinning and burning treatments. However, just 2 years after the treatments *Ailanthus* stems were widely and abundantly distributed (15, 16). This suggests that the rate of spread is much faster than the Sonoma Univ. study indicates, especially after forest management activities.
II. Environmental Effects	1. Alteration of ecosystem/community composition? YES ☒ NO ☐ Notes: Easily invades and crowds out native species. Also, has allelopathic properties which prevent re-establishment of other plants.
	2. Alteration of ecosystem/community structure? YES ☒ NO ☐ Notes: Can affect all plants from the canopy to the ground.
	3. Alteration of ecosystem/community functions and processes? YES ☒ NO ☐ Notes: By effectively eradicating many native plant species, including trees, this plant can significantly change the plant/animal community where it invades. *Ailanthus* may inhibit the regeneration of native trees (15, 16).
	4. Allelopathic properties? YES ☒ NO ☐ Notes: Releases toxins that prevent the establishment of other plant species. (17, 18, 19).
D. SOCIO-ECONOMIC Effects	
I. Positive aspects of the species to the economy/society:	Notes: Can be used as timber. Sometimes planted in places with a lot of limestone to aid in reforestation. Sometimes used as street tree. Planted in cities because it is extremely tolerant of air pollution, and it is somewhat resistant to ozone exposure." (Nature Conservancy–Elements of Stewardhship Abstract http://tncweeds.ucdavis.edu/esadocs/documnts/ailaalt.pdf) Provides some erosion control.
II. Potential socio-economic effects of restricting use:	Notes: Switching to other species for erosion control and a pollution tolerant street trees. Used for a variety of ailments in Chinese traditional medicine. (20, 22) *Ailanthus* has been used in revegetating acid mine spoils because of its ability to tolerate low pH, high soluble

	salt concentrations, and low phosphorus levels (3).
III. Direct and indirect effects :	Notes: Extensive root system can cause damage to sewers and foundations. Roots also interfere with shelterbelt plantings. All parts of trees have foul smell, but especially the flowers. The male trees have a stronger odor, almost nauseating, described as rancid peanut butter. Can easily become agricultural pest. A proven invasive, however, it is dioecious and non-invasive male clones have been selected including the cultivar 'Metro'.
IV. Increased cost to a sector:	Notes: Any damage caused by root systems, education, replacing trees in cities and those used in erosion control, removal of species.
V. Effects on human health:	Notes: Sap of the plant can cause myocarditis (inflamation of heart tissue) if internalized. Persons have been hospitalized after cutting the trees with chain saws. Some people are allergic to the tree's pollen. Dermatitis as been reported after being in contact with the tree's leaves or flowers. Gastroenteritis is possibly caused by roots and above ground tree. Sap of the plant may cause myocarditis (inflamation of the heart muscle) if internalized (23). Ailanthus is also suspected of causing gastroenteritis (inflamation of the stomach and intestine) (23, 24, 25). Some people have respiratory allergies to the tree's pollen (26), and dermatitis (inflamation of the skin) has been reported after contact with the tree's leaves and/or flowers (27).
E. CONTROL AND PREVENTION	
I. Costs of Prevention (including education; please be as specific as possible):	Notes: Education, machinery, man-power, chemicals, equipment, monitoring, surveying, planting of native species to reinforce community, continued application of above costs.
II. Responsiveness to prevention efforts:	Notes: Fairly good with repeated eradication methods and long-term monitoring, especially if done before infestations get abundant..
III. Effective Control tactics:	Mechanical ☒ Biological ☐ Chemical ☒ Times and uses: Targeting large female trees can reduce spread from seed. Establishing thick cover of native trees can avoid re-establishment of invasive. Follow-up monitoring will be necessary at least once a year. (1) Young seedlings can be pulled/dug out when soil is moist. Be sure to remove all roots and fragments to avoid regrowth. Repeated cutting of small populations or those in dense shade can eliminated plant, but usually cutting is ineffective b/c of the plant's ability to regrow. (2)Herbicides are most effective method of eradication. The following herbicides can be used: 2% Glyphosate:

	Roundup, Rodeo, Accord (all non-selective); 2% Triclophyr: Garlon 3A, Garlon 4 (all selective–don't kill grasses). The herbicide should be mixed w/water and non-ionic surfactant. The mixture should be applied to leaves and green stems (sprouts, suckers) thoroughly. Application should be done between June and September. Other effective herbicides include: dicamba, imazapyr, and metsulfuron methyl. (3) Basal bark treatment also an option. Best to apply in later winter/early spring. "Mix up a solution of 20% (as low as 10% in summer depending on objectives) concentration of oil-soluble triclopyr product (e.g., Garlon® 4) in 80% oil (fuel oil, diesel, kerosene, mineral oil, or special vegetable oils). Another option is to use a pre-mixed, ready-to-use triclopyr product designed for basal bark (and cut stump) application (e.g., Pathfinder® II). Using a handheld or backpack type sprayer, apply the mixture in a 12 inch wide band around the entire circumference of the tree base with no "skips". The basal bark method is generally used for trees that are less than 6 inches in diameter, though slightly larger stems may also be treated effectively by thoroughly treating bark up to 24 inches in height. Followup foliar herbicide application (see above) to basal sprouts and root suckers may be necessary. Another herbicide which has been shown to be effective for basal bark control of ailanthus is imazapyr (e.g., Chopper®, Stalker®). This is sometimes used in a combination with triclopyr at a concentration of 15% Garlon® 4 and 5% Stalker® in 80% oil diluent." (4) "The hack-and-squirt or injection method is very effective and minimizes sprouting and suckering when applied during the summer. This method requires first making downward-angled cuts into the sapwood around the tree trunk at a comfortable height, using a hand ax. With spray bottle or wand in the other hand, squirt a straight (100%) concentration of a water-soluble triclopyr product (e.g., Garlon® 3A) into the cuts within a minute or two, applying 1-2 milliliters into each cut (typically 1-2 squirts of a trigger squirt bottle) so that the bottom of the cut is covered, but liquid doesn't run out of it. Generally, you would make about 1 hack cut for each inch of diameter plus one (i.e., for a 10 inch diameter tree, make about 11 cuts). Space the cuts so that about 1-2 inches of uncut living tissue remains between them. This method can be used with trees of any size, though it is most productive with stems over 2 inches in diameter. Monitor the treatment area and be prepared to follow-up with a foliar application the next year to control any basal sprouts or root suckers that might emerge." (5) "A potential biological control for ailanthus may lie in several fungal pathogens, (Verticillium dahliae and Fusarium oxysporum) that have been isolated from dead and dying ailanthus trees in New York and in southern and western Virginia." (6) "Herbicide mixtures containing glyphosate, metsulfuron methyl, triclophyr, dicamba, or imazapyr, alone or in combination, will provide control when applied to foliage" (http://rnrext.cas.psu.edu/PDFs/Tree%20of%20Heaven.pdf) (All quotes from nps.gov fact sheet, unless otherwise specified) **After removal, replanting area w/natives can help prevent re-establishment. Some natives that may be used include: box elder (Acer negundo), smooth sumac (Rhus glabra), black walnut (Juglans nigra), green or white ash (Fraxinus pennsylvanica or

	americana), fringetree (Chionanthus virginicus), staghorn sumac (Rhus typhina) The Garlon 4 basal bark method is by far the best to use – we have little success with any method that cuts into the tree. Foliar application on this species is a disaster – way too much area to cover even on a one year old seedling so there is an unacceptable amount of nontarget damage. See Burch and Zedeker reference on control.
IV. Minimum Effort:	Notes: Hand weeding, cutting, digging small plants when soil is moist, and applying combinations of the above listed herbicides to treat larger plants and populations. Repeated application of both these methods will be necessary for years until plant is entirely eradicated. During this time, monitoring should help to rate the effectiveness of the methods and how often they will need to be carried-out in the future.
V. Costs of Control:	Notes: Educating landowners and others, costs of employees needed to conduct manual and chemical labor and monitoring, cost of herbicides, machines, any costs that may be needed to restore natural ecosystem/plant community.
VI. Cost of prevention or control vs. Cost of allowing invasion to occur:	Notes: Education, machinery, man-power, chemicals, equipment, monitoring, surveying, planting of native species to reinforce community, continued application of above costs vs. loss of ecosystem structure, function, composition, loss of diversity, native plant/animal species loss, loss of aesthetic landscape (consequently, loss of tourist money), continued needed repairs to sidewalks, building foundations, and sewers
VII. Non-Target Effects of Control:	Notes: May involve removal of trees from high-traffic areas, such as city sidewalks/alleys, etc., places where it is used to add green space to cities may need to re-planted with another species for aesthetic purposes, places where it is performing erosion control may also need to be addressed in terms of continued control, using herbicides often puts other non-target plants at risk of being poisoned.
VIII. Efficacy of monitoring:	Notes: Monitoring post treatment and in search of new infestations can be very effective.
IX. Legal and landowner issues:	Notes: Land owners may need to be educated regarding the proper maintainance/actions to be taken when dealing w/the tree.

F. REFERENCES USED:

☒ UW Herbarium
☐ WI DNR
☒ TNC
☒ Native Plant Conservation Alliance
☒ IPANE
☒ USDA Plants

Number	Reference
1	USDA Forest Service - Center for Wood Anatomy Researchhttp://www2.fpl.fs.fed.us/TechSheets/HardwoodNA/htmlDocs/ailaeng.html
2	USDA Forest Service–Northeastern Area–Ailanthus http://www.na.fs.fed.us/spfo/pubs/silvics_manual/Volume_2/ailanthus/altissima.htm
3	The Nature Conservancy–The Global Invasive Species Initiative– http://tncweeds.ucdavis.edu/esadocs/documnts/ailaalt.pdf
4	The National Park Service–U.S. Department of the Interior–Nature and Science http://www.nature.nps.gov/biology/ipm/manual/exweeds2.cfm
5	The National Park Service–U.S. Department of the Interior–Plant Invaders of Mid-Atlantic Natural Areas: Trees http://www.nps.gov/plants/alien/pubs/midatlantic/aial.htm
6	Columbia University–Introduced Species Summary Project http://www.columbia.edu/itc/cerc/danoff-burg/invasion_bio/inv_spp_summ/ailanthus_altissima.html
7	Ohio Agricultural Research and Development Center–Ohio Perennial and Biennial Weed Guide http://www.oardc.ohio-state.edu/weedguide/singlerecord.asp?id=410
8	Botany Department, Morris Arboretum of University of Pennsylvania–The Pennsylvania Flora Project–Tree of Heaven http://www.paflora.org/Ailanthus%20altissima.PDF
9	Penn State College of Agricultural Sciences–Cooperative Extension, Centre County–Fact Sheet: Invasive Weeds http://rnrext.cas.psu.edu/PDFs/Tree%20of%20Heaven.pdf
10	California Invasive Plant Council–http://www.cal-ipc.org/ip/management/wwh/pdf/19655.pdf
11	Victorian Resources Online–Department of Primary Industries http://www.dse.vic.gov.au/dpi/vro/vrosite.nsf/pages/invasive_tree_heaven
12	Sonoma State University–Spread Dynamics of an Invasive Species: Tree of Heaven https://www.sonoma.edu/users/s/stokes/StokesResearchsub3.htm
13	Invasive and Exotic Species–Ailanthus altissima http://www.invasive.org/weeds/asian/ailanthus.pdf
14	Ed Hasselkus, UW Emeritus Horticulture Professor. Comments on Invasive Plant Classification 2007.
15	Hutchinson et al. 2004. Abundant establishment of Ailanthus altissima (tree-of-heaven) after restoration treatments in an upland oak forest. In Proceedings of the 14th Central Hardwood Forest Conference.
16	Rebbeck et al. 2005. Invasive Plants Affecting the Management of Ohio's Forests. In Proceedings of the 16th US Dept. of Ag. Interagency research forum on gypsy moth and other invasive species.
17	Heisey, RM. 1990. Evidence for allelopathy by tree of heaven (*Ailanthus altissima*). Journal of Chemical Ecology 16:2039-2055.
18	Heisey, RM. 1996. Identification of an allelopathic compound from *Ailanthus altissima* and characterization of its herbicidal activity. American Journal of Botany 83:192-200.
19	Mergen, F. 1959. A toxic principle in the leaves of *Ailanthus.* Botanical Gazette 121:32-36.
20	Purdue University-Center for New Crops and Plant Products-The New Crop Resource On-line Program http://www.hort.purdue.edu/newcrop/duke_energy/Ailanthus_altissima.html
21	Knapp, Liza B.; Canham, Charles D. (October - December, 2000). "Invasion of an Old-Growth Forest in New York by Ailanthus altissima: Sapling Growth and Recruitment in Canopy Gaps". *Journal of the Torrey Botanical Society* **127** (4): 307-315.
22	Center for Wood Anatomy Research-USDA Forest Service-Forest Products Laboratory http://www2.fpl.fs.fed.us/techsheets/HardwoodNA/htmlDocs/ailaeng.html
23	Bisognano et al. 2005. Myocarditis from the Chinese Sumac Tree. Annals of Internal Medicine. Jul. 19; 143(2):159-160.
24	Mitchell and Rook. 1979. Botanical dermatology. Greenglass Ltd, Vancouver, B.C., Canada. 787 pp.
25	Muenscher. 1975. Poisonous plants of the United States. Revised. Collier Books, New York, N.Y., USA. 277 pp.
26	Ballero et al. 2003. Allergy to *Ailanthus altissima* (tree of heaven) pollen. Allergy. 58(6):532–533.
27	Derrick EK and Darley CR (1994) Contact reaction to the tree of heaven. Contact Dermatitis 30(3): 178

Author(s), Draft number, and date completed: Ashlie Kollmansberger, 03-23-07

Reviewer(s) and date reviewed: Ellen Jacquardt, 07-19-07

Approved and Completed Date: Thomas Boos, 09-13-07