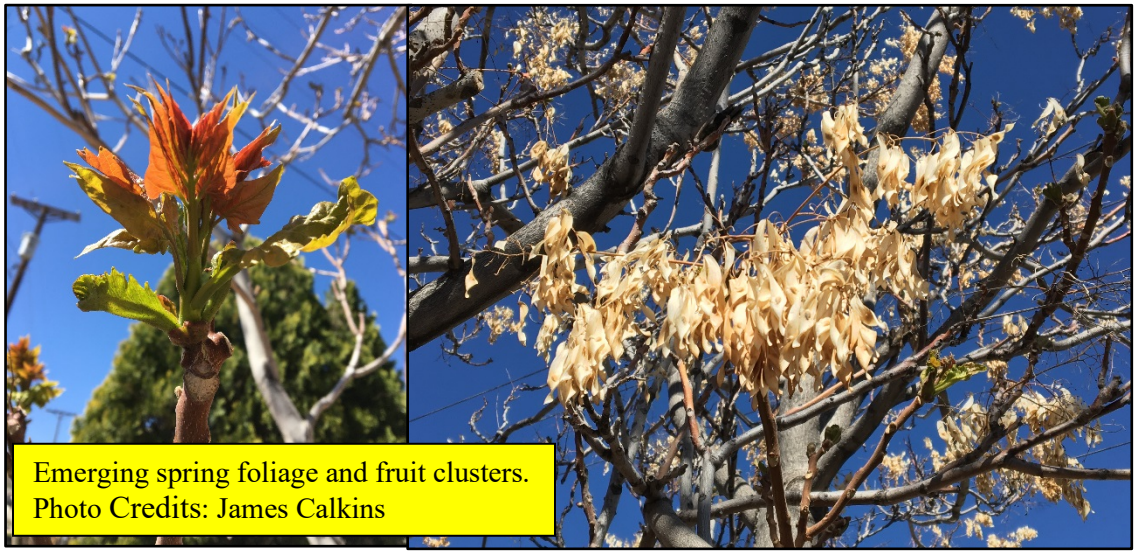
MN NWAC Risk Assessment Worksheet (04-2011)	Common Name	*Latin Name*
	Tree of Heaven, Tree-of-Heaven (sometimes simply called ailanthus or referred to by several other colloquial names including stinking ash, stink tree, and tree of hell)	***Ailanthus altissima* (Mill.) Swingle** (synonyms: *Ailanthus glandulosa*, *Ailanthus sinensis*, *Rhus cacodendron*, *Toxicodendron altissimum*, and many others)
Reviewer	**Affiliation/Organization**	**Date (mm/dd/yyyy)**
Original Reviewer: Ken Graeve	**Minnesota Department of Transportation**	**08/25/2014**
Current Reviewer: James Calkins	**Minnesota Nursery and Landscape Association**	**09/17/2019**

Species Description:

Tree of heaven (*Ailanthus altissima*) is a member of the Simaroubaceae (Quassia Family) and is native to northeastern and central China, Taiwan, and North Korea. Unlike the other members of the Simaroubaceae which are tropical species, tree of heaven is a temperate species. Although fossil evidence indicates *Ailanthus* was once native to western North America as recently as the middle of the Miocene period (23-5.3 million years ago; Corbet and Manchester, 2004), the species ultimately disappeared from the North American fossil record. In more recent history, tree of heaven was first introduced to North America in the United States in Philadelphia, PA, in 1784 from England. A second introduction in eastern North America has also been documented in Flushing, Long Island, NY, in 1820, and tree of heaven was subsequently introduced on the West Coast of the United States by Chinese immigrants in the 1850s and has primarily been planted as a landscape and boulevard tree.



Emerging spring foliage and fruit clusters.
Photo Credits: James Calkins

Tree of heaven is a fast-growing (3 to more than 6 feet per year when young), medium to large, shade tree (50-90 feet tall) with large (1 to 4 feet long), alternate, pinnately-compound leaves with 10 to 40 stalked, lanceolate leaflets with entire (smooth) margins except for one or two glandular teeth at the base of each leaflet. Although usually larger and coarser, at first glance, the leaves resemble the pinnately-compound

leaves of smooth (*Rhus glabra*) and staghorn (*Rhus typhina*) sumac and younger trees are often mistaken for these native species and sometimes for eastern black walnut (*Juglans nigra*), butternut (*Juglans cinerea*), and hickory (*Carya* spp.) which are also native. Unlike tree of heaven, however, all of these native species have leaflets with serrated margins. The leaves of tree of heaven are tinged with bronze when they emerge in the spring (see image), becoming dark green when mature and the foliage and other parts of tree of heaven give off a strong, offensive odor when bruised. The twigs lack terminal buds and are stout (especially for new, vigorous root suckers), smooth, and greenish-brown in color with large, heart-shaped leaf scars and a large, brown, spongy pith. The bark on older branches and trunks becomes gray and slightly furrowed. Several named cultivars have been introduced including 'Erythrocarpa' (female), 'Metro (male), and 'Pendulifolia' (Dirr, 1990).

Tree of heaven is dioecious (individual plants male or female) and produces small, yellowish-green to reddish flowers in large terminal panicles; male flowers are produced in larger numbers and the flower clusters on male plants are showier than those of female plants. The flowers are pollinated by insects. The fruit is a single-seeded, twisted samara and the large clusters of greenish samaras, which typically develop a reddish-orange blush on the upper surface in response to exposure to sunlight, are very showy. The samaras ultimately become light tan when mature and are persistent through the winter months. Tree of heaven is a prolific seeder and individual trees can produce at least 300,000 seeds and often many more. The samaras are effectively dispersed by wind and may also be transported by water. Although the tendency is variable, tree of heaven also reproduces vegetatively by root suckers and can produce large colonies. This suckering habit is similar to the suckering of smooth and staghorn sumac which, when combined with similar foliar characteristics, is another reason why these species are sometimes confused. Suckering of tree of heaven is enhanced when trees are injured or cut down and this tendency has implications for managing tree of heaven infestations.

Tree-of-heaven is an adaptable, sun-loving species that grows almost anywhere except on saturated soils and in dense shade and is adapted to urban conditions including disturbed sites, acidic and alkaline soils, pollution, and drought. It has become a common weed in many areas where it has been introduced including in southeastern Canada and much of the United States where it can be found primarily in open, disturbed, urban and rural areas including roadsides, railroad corridors, roadsides, fencerows, woodland edges, and forest openings from southeastern Canada and the northeastern United States to Iowa and south to Texas and northern Florida. In the western United States, tree of heaven is common from Washington and Idaho and south through California, Arizona, and New Mexico. Although tree of heaven will tolerate light shade, it is intolerant of dense shade and cannot compete under a closed forest canopy, but it can colonize forested areas by growing quickly to take advantage of forest openings that result when trees die or are impacted by storms and other disturbances. Tree of heaven is also allelopathic which can enhance its invasive tendencies.

Tree of heaven (*Ailanthus altissima*) has been documented as a problematic invasive species across much of the United States. It is present in Minnesota, but is not naturalized (thus far, only two plants have been documented in the state), and whether or not the species can thrive in the state given current climatic conditions and its lack of cold hardiness (USDA Cold Hardiness Zone 5) is debatable. From the perspective of potential invasiveness in the state, given that tree of heaven is not reliably hardy under current conditions, discussion should cautiously consider whether or not the species could thrive in Minnesota in the near future if warmer temperatures become the norm as a result of climate change and warmer winter temperatures.

Current Regulation in Minnesota: Tree of heaven (*Ailanthus altissima*) is currently listed and regulated as a Restricted Noxious Weed in Minnesota (first listed in 2016); may not be grown or sold in the state (existing plants do not need to be eradicated or controlled).

Box	Question	Answer	Outcome
1	Is the plant species or genotype non-native?	No. Tree of heaven is native to northeastern and central China, Taiwan, and North Korea (Dirr, 1990; Global Invasive Species Database, 2005; Fryer, 2010; USDA NRCS, 2014; Jackson and Gover, 2018). *Ailanthus altissima* was first introduced to North America in the late 1700s for horticultural reasons (Fryer, 2010; Jackson and Gover, 2018).	Go to Box 3
3	Is the plant species, or a related species, documented as being a problem elsewhere?	Yes. Tree of heaven has been reported as invasive in New England, the mid-Atlantic States, California, the Pacific Northwest, and the southwestern United States. Tree of heaven has also been reported as weakly invasive in the middle and southern Great Plains and is reportedly spreading in the South (Fryer ,2010). Tree of heaven is listed as invasive in 46 states by a variety of sources (Global Invasive Species Database, 2005; USDA NRCS, 2019 – Figure 3) and, in addition to Minnesota where it is listed as a Restricted Noxious Weed, is currently regulated in Connecticut (Invasive, Banned), Massachusetts (Prohibited), New Hampshire (Prohibited), and Vermont (Class B Noxious Weed) (USDA NRCS, 2019).	Go to Box 6
6	Does the plant species have the capacity to establish and survive in Minnesota?	Broadly speaking, tree of heaven may have the capacity to survive in Minnesota, but only in a few locations along the Minnesota/Iowa border based on cold hardiness. Individual trees have been documented in Minnesota, but the species is not naturalized in Minnesota. It is generally believed that tree of heaven is cold hardy to USDA Zone 5 and, based on the current USDA Plant Hardiness Zone Map (2012 – Figure 5), only portions of five Minnesota counties along the Minnesota/Iowa border are in USDA Plant Hardiness Zone 5a (-15 to -20ºF; Jackson, Martin, Fairbault, Austin, and Houston Counties). As a result, the majority of Minnesota is currently outside the range where tree of heaven would be expected to perform well based on cold hardiness, but because the species has been found in the state (albeit injured by cold temperatures), and is documented as invasive in other places that experience Zone 5 temperatures, the possibility exists that tree of heaven could become	See Question 6A

		problematic in extreme southern Minnesota. In addition, if winter temperatures continue to increase as they have based on the most recent, 2012 iteration of the USDA Plant Hardiness Zone Map (there were no Zone 5 conditions in Minnesota based on the 2009 map and Zone 2 has disappeared from northern Minnesota; Plantmaps.com, 2019 – Figure 6), and because the average minimum winter temperatures that are currently being experienced in southern Minnesota are just below the range where tree of heaven could potentially survive and become problematic, the range where tree of heaven could become established in Minnesota could expand if the southern third of the state becomes warmer. As a result, this is a situation where the potential for a warming climate should at least be considered in assessing risk. It has been suggested that tree of heaven requires an annual mean temperature of 8 degrees Celsius (46ºF; the annual mean winter temperature in Minnesota ranges from 32ºF in International Falls to 49ºF in Winona based on 1971-2000 data) and this lack of cold hardiness may limit the spread and establishment of tree of heaven in colder regions like Minnesota (Wikipedia, 2019). Future climate projections currently indicate that Minnesota will be warmer in the future, with plant hardiness zones possibly shifting up to a full zone every 30 years (US Global Change Research Program, 2009), and there is already some data showing that the current USDA plant cold hardiness zones may already be outdated (Krakauer, 2012). If these climate projections are realized, there is a possibility that tree of heaven may be able to survive in southern Minnesota in a relatively short timeframe. Based on this information, when considering climate projections for the purposes of this risk assessment, the questions to be considered are how quickly might a warming climate allow tree of heaven to survive, reproduce, and become established and naturalized in Minnesota and is the timeframe of the projected warming short enough to justify regulation of tree of heaven under the Minnesota Noxious Weed Law at this time. An important consideration is the scenario where a species can survive but not thrive in Minnesota (which is likely the current status in Minnesota)), and is therefore not regulated, but could become a problem as an invasive species in response to warmer temperatures in the future. Although tree of heaven is not considered reliably cold hardy in Minnesota at this time, without regulation it is possible that, even though trees would likely suffer	

		considerable winter injury under current conditions, tree of heaven could become more widespread through planting for horticultural purposes or through inadvertent introduction and spread. Should the climate then warm sufficiently to allow tree of heaven to become invasive (and thus a clear candidate for regulation) the species might already be widely distributed and the opportunity to prevent tree of heaven from becoming a problem in Minnesota may have been missed.	
	A. Is the plant, or a close relative, currently established in Minnesota?	No. Present, but not established. Tree of heaven has been documented twice in Minnesota; first in Ramsey County in 2012 in a somewhat sheltered site adjacent to a building in a landscape bed in St Paul (Figure 1) and more recently along Hwy. 26 between La Crescent and Brownsville in Houston County in 2017 (Figure 2). Both reports involved individual trees with a few root suckers and in both cases the trees and suckers have been treated with the goal of elimination. The specimen in St. Paul was located within the heat island of the Minneapolis/St. Paul metropolitan area and had suffered significant die-back during the cold winter of 2013-2014 (see photos) and, given its condition and the die-back observed following the winter of 2013-2014, it is suspected that die-back has occurred in previous winters. While the site is somewhat sheltered, the dieback generally seems to have occurred on the branches that extend above a sheltering wall and the adjacent building, where they were likely exposed to colder temperatures and winter winds that might have a desiccating effect. The specimen that was documented in Houston County was growing in the Hwy. 26 right-of-way between La Crescent, MN, and Brownsville, MN, along the Mississippi River across from Pleasant Valley, WI. As reported in a Minnesota Department of Transportation report (MNDOT, 2017), the tree consisted of a single primary stem (about 8” in diameter at breast height/DBH) and several, smaller root sprouts (up to 3” DBH). Although the location is close to the current boundary of USDA Plant Hardiness Zone 5a (-15 to -20°F), the plant was located in Zone 4b (-20 to -25°F) and exhibited significand dieback that was believed to be the result of winter injury. Clearly the plant had been able to survive, but there was no evidence of seed production although the tree was spreading vegetatively to become a small	Go to Question 6B

		colony through root suckers. The lack of seed production could have been the result of winter injury, the lack of a nearby pollinator, or the tree being a male since the species is dioecious (individual trees male or female). In short, two tree of heaven specimens have been documented in Minnesota, one in downtown St. Paul and another in Houston County in the southeastern corner of the state and in both cases the trees exhibited significant winter injury and it is believed the trees have been eradicated. Although the tree located in east-central Houston County had suffered significant winter injury, whether or not the species could survive and spread by seed in sheltered valleys in southeastern Minnesota is unknown given that USDA Plant Hardiness Zone 5 conditions (Zone 5a; -15 to -20ºF) are present in the southeastern corner of the county and in portions of four other Minnesota counties along the Minnesota/Iowa border.	
	B. Has the plant become established in areas having a climate and growing conditions similar to those found in Minnesota?	Yes, but it should be noted that the cold hardiness reports for tree of heaven are mixed. Tree of heaven is said to occur in USDA Cold Hardiness Zones 4-8 in North America (Fryer, 2010). It has also been reported that tree of heaven is able to survive temperatures as low as -27ºF (NatureServe, 2014) to -38ºF (Fryer, 2010), which would indicate that the species could survive in zones as cold as Zones 4b to 3a, hardiness zones that have average annual minimum winter temperatures that range from -25 to -30ºF and -35 to -40ºF, respectively (USDA ARS, 2012), and would theoretically allow the species it to survive across the entire state. In addition, the seedlings of tree of heaven are reportedly vulnerable to injury by cold temperatures, but older plants are more tolerant so it the species could possibly become established in colder regions that get occasional multiple-year periods with milder winters (Fryer, 2010). According to Michael Dirr (1990), tree of heaven is hardy to Arnold Arboretum Cold Hardiness Zone 4 which is generally equivalent to USDA Plant Hardiness Zone 5. That tree of heaven is only reliably cold hardy to USDA Zone 5 is further supported by EDDMapS reporting as most reports are in USDA Plant Hardiness Zone 5a or warmer (Figure 4) and the fact that the two trees that have been documented in Minnesota (both in Zone 4b) have suffered winter injury. This suggests the species is only hardy to USDA Plant Hardiness Zone 5 and would not be expected to survive and thrive in Minnesota under current	Go to Box 7

		conditions with the exception of a few locations along the Minnesota/Iowa border where a few pockets of USDA Plant Hardiness Zone 5a exist and where it may be warm enough for the survival and performance of tree of heaven to be a possibility. In addition, the two trees that have been documented in Minnesota have survived for several years and have grown to a relatively large size.	
7	Does the plant species have the potential to reproduce and spread in Minnesota?		
	A. Does the plant reproduce by asexual/vegetative means?	Yes. The production of vegetative shoots from root suckers resulting in colony formation is common for *Ailanthus altissima*, even for trees with uninjured stems, and even more so when trees are injured or cut down, and suckers can appear up to 50 to 90 feet from the parent tree (Fryer, 2010).	Go to Question 7B
	B. Are the asexual propagules effectively dispersed to new areas?	No. Dispersal of asexual propagules (i.e., root pieces) would probably require mechanical transport by human activity or possibly movement of soil from hillsides or stream banks during flooding.	Go to Question 7C
	C. Does the plant produce large amounts of viable, cold-hardy seeds?	Yes. *Ailanthus altissima* has been reported to have seed production rates 40 times higher than the next-highest producing species in a Connecticut hardwood forest, with 12" DBH trees producing 400,000 and 2 million seeds per tree in two different years. It has been reported that seed viability is high (Fryer, 2010) and more specifically as high as 65% or higher (Wickert et al., 2017). Wickert et al. (2017) have also suggested that few invasive woody species in the United States have annual seed production rates that surpass tree of heaven and have reported that seed production can exceed more than 1-million seeds/year, continue for more than 100 years, and begin for trees as young as 4–5 years old. Based on their findings, they suggest that a female tree that lives for 40 years can easily produce 10 million seeds while long-lived trees with high fecundity may produce more than 50 million seeds during a 100-year lifetime.	Go to Question 7F
	D. If this species produces low numbers of viable seeds, does it have a high level of seed/seedling vigor or do	***The seeds of tree of heaven have a short period of dormancy (one year) and do not develop a persistent seed bank and seedling establishment has been reported as low, but, nevertheless, Ailanthus altissima does frequently spread by seed (Fryer, 2010).***	**This text is provided as additional information not directed through the decision tree process**

	the seeds remain viable for an extended period?		**for this particular risk assessment.**
	E. Is this species self-fertile?	***No. Ailanthus altissima is a dioecious species (individual trees are male or female; Fryer, 2010; Jackson and Gover, 2018).***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	F. Are sexual propagules – viable seeds – effectively dispersed to new areas?	Yes. Seed is dispersed by wind, water, vehicles, and machinery and many studies have documented the establishment of infestations from seed (CABI, 2019; Fryer, 2010).	Go to Question 7I
	G. Can the species hybridize with native species (or other introduced species) and produce viable seed and fertile offspring in the absence of human intervention?	***No. There are no compatible species in Minnesota.***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	H. If the species is a woody (trees, shrubs, and woody vines) is the juvenile period less than or equal to 5 years for tree species or 3 years for shrubs and vines?	***Yes. Tree of heaven is a precocious species and can begin seed production at an early age (1 to 10 years old) and trees in one study averaged 4.8" DBH at first seed production (Fryer, 2010).***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	I. Do natural controls exist, species native to Minnesota, which are documented to effectively prevent the spread of the plant in question?	No. Other than the species not being reliably cold hardy in most of Minnesota, natural controls do not exist in the state. Researchers in Pennsylvania are studying a native fungus (*Verticillium nonalfalfae*) that causes wilt and high mortality in *Ailanthus* trees, but the research is preliminary and more information is needed on the efficacy of the fungus as a potential biocontrol agent and on the host specificity and cold hardiness of the fungus (Nisley, 2014; Swayne, 2014).	Go to Box 8.

8	Does the plant species pose significant human or livestock concerns or has the potential to significantly harm agricultural production, native ecosystems, or managed landscapes?		
	A. Does the plant have toxic qualities, or other detrimental qualities, that pose a significant risk to livestock, wildlife, or people?	No, but not unlike other native and introduced species, tree of heaven can sometimes be a nuisance. Pollen is allergenic to some people and exposure to sap can cause dermatitis for some individuals; in addition, root systems can sometimes damage buildings, foundations, and water facilities (Fryer, 2010; Global Invasive Species Database, 2014).	Go to Question 8B
	B. Does, or could, the plant cause significant financial losses associated with decreased yields, reduced crop quality, or increased production costs?	No. Tree of heaven is not an agricultural weed.	Go to Question 8C
	C. Can the plant aggressively displace native species through competition (including allelopathic effects)?	Yes. *Ailanthus altissima* can crowd out native vegetation, reduce diversity of native plants, and alter the succession of natural ecosystems through allelopathic effects (allelopathic compound = ailanthone; Wikipedia, 2019). The species can tolerate some shade but is intolerant of heavier shade and cannot compete under a closed forest canopy (Jackson and Gover, 2018). As a result of its ability to colonize disturbed areas, tree of heaven is common in urban areas and can exhibit very rapid growth rates under good conditions (Fryer, 2010; NatureServe, 2014; Jackson and Gover, 2018). Besides urban areas, tree-of-heaven can be found in a variety of other disturbed sites including woodland edges, roadsides, railways, and fencerows, and can also be found in riparian areas and forest openings (Jackson and Gover, 2018). It has been reported that tree of heaven can endanger forest regeneration and restoration efforts in West Virginia, Ohio, and Pennsylvania (Nisley, 2014)	Go to Box 9

		and is considered a "dangerous weed" in forest plantations (NatureServe, 2014). Because *Ailanthus altissima* is primarily reported as being invasive on open, disturbed sites, some sources consider it to be only slightly or moderately invasive. However, because of its allelopathic effects, potential effects on soil chemistry and litter layers, interference with natural succession and forest regeneration, and ability to invade and alter riparian ecosystems, it is considered highly invasive and a serious ecological threat by others (Fryer, 2010; NatureServe, 2014).	
	D. Can the plant hybridize with native species resulting in a modified gene pool and potentially negative impacts on native populations?	***No. There are no compatible native species in Minnesota.***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	E. Does the plant have the potential to change native ecosystems (adds a vegetative layer, affects ground or surface water levels, etc.)?	***Yes. Ailanthus altissima can reduce the thickness of the leaf litter layer, decrease soil carbon:nitrogen ratios, and increase the susceptibility of ecosystems to invasion by other invasive species. Infestations can also alter natural ecosystem succession by invading early succession habitats and crowding out native vegetation through rapid growth rates, extensive vegetative reproduction (colony production), and allelopathic impacts (Fryer 2010; NatureServe 201; Jackson and Gover 2018).***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	F. Does the plant have the potential to introduce or harbor another pest or serve as an alternate host?	***Yes. Ailanthus altissima is the primary host of spotted lanternfly (Lycorma delicatula) and may spread to ther parts of North America including Minnesota (USDA APHIS, 2019); it is possible that the presence of tree of heaven in Minnesota could enhance the establishment and spread of this invasive and destructive insect should tree of heaven become established in Minnesota.***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
9	Does the plant species have clearly defined benefits that outweigh		

	associated negative impacts?		
	A. Is the plant currently being used or produced and/or sold in Minnesota or native to Minnesota?	No. *Ailanthus altissima* is not native to Minnesota or reliably cold hardy in Minnesota and is, therefore, not currently produced or sold by Minnesota nurseries; should Minnesota's climate continue to become warmer in response to climate change, the concern is that the species could gain popularity and value as a nursery and landscape species in Minnesota which could lead to problems with invasiveness in the future.	Go to Box 10
	B. Is the plant an introduced species and can its spread be effectively and easily prevented or controlled, or its negative impacts minimized through carefully designed and executed management practices?	***Yes and No. Yes, Ailanthus altissima is an introduced species in Minnesota, and, no, the spread of tree of heaven could not be easily prevented or controlled and it would be difficult to minimize its negative impacts were the species to become established in the state.***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	C. Is the plant native to Minnesota?	***No. Tree of heaven is not native to Minnesota; it is native to northeastern and central China, Taiwan, and North Korea (see Box 1).***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	D. Is a non-invasive, alternative plant material commercially available that could serve the same purpose as the plant of concern?	***Yes. Although Ailanthus altissima is an adaptable and attractive shade tree with interesting fruits that provide winter interest, given its invasive tendencies, and the fact that it is not currently grown or sold in the state, there are many alternatives available that are better choices for Minnesota landscapes.***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	E. Does the plant benefit Minnesota to a greater extent than the negative	***No. Ailanthus altissima is not currently grown or sold in Minnesota and, therefore, does not currently benefit the state.***	**This text is provided as additional information not**

	impacts identified at Box #8?		**directed through the decision tree process for this particular risk assessment.**
10	Should the plant species be enforced as a noxious weed to prevent introduction &/or dispersal; designate as prohibited or restricted?	For several reasons, it would probably be wise to change the listing of heaven (*Ailanthus altissima*) from Restricted Noxious Weed to Prohibited/Eradicate Noxious Weed in Minnesota to prevent the production and sale of tree of heaven in Minnesota with the goal of preventing the future establishment and spread of the species in the state should the climate warm sufficiently to allow tree of heaven to thrive in the state. Because *Ailanthus altissima* is a dioecious species (individual plants are male or female), only listing female trees as Restricted Noxious Weeds and allowing the production and sale of male trees might be an option except that the species is the primary, but not the only (a number of species native to MN are susceptible to attack), host of spotted lanternfly (*Lycorma delicatula*) and the presence of tree of heaven in MN could enhance the establishment and spread of this invasive and destructive insect should tree of heaven become established in Minnesota and spotted lanternfly be introduced in the state; spotted lanternfly has not yet been documented in Minnesota, but was documented in North America for the first time in Pennsylvania in 2014. Since then, spotted lanternfly has become established in southeastern PA and has spread to several other northeastern and mid-Atlantic states including Delaware, New Jersey, and Virginia; individual specimens have also been documented in Maryland and New York (United States Department of Agriculture /USDA, 2019).	See Question 10A
	A. Is the plant currently established in Minnesota?	No. Only two trees with suckers have been documented in Minnesota (in both cases the trees have subsequently been eradicated) and there are currently no records of naturalized populations in the state. Given the increased likelihood that tree of heaven may invade portions of southern Minnesota as a result of warmer temperatures (areas of USDA Plant Hardiness Zone 5a; -15 to -20°F) are now present in five of Minnesota's southern border counties), its role as the primary host of spotted lanternfly (*Lycorma delicatula*), and the possibility that winter temperatures in Minnesota may continue to become warmer in future years, the listing of	List tree of heaven (*Ailanthus altissima*) as a Prohibited/Eradicate Noxious Weed.

		Ailanthus altissima should be changed from its current listing as a Restricted Noxious Weed to a Prohibited/Eradicate Noxious Weed.	
	B. Does the plant pose a serious human health threat?	***No, not a serious threat. Ailanthus altissima poses a minimal health threat to people (allergic reactions to pollen and dermatitis); the possibility that exposure to the sap could cause dermatitis for some people would likely be the most common for people working to control existing plants (Fryer, 2010).***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
	C. Can the plant be reliably eradicated (entire plant) or controlled (top growth only to prevent pollen dispersal and seed production as appropriate) on a statewide basis using existing practices and available resources?	***In general, Yes. Although it is difficult to control large infestations of Ailanthus altissima, control/eradication is possible and, with due diligence, should be possible in Minnesota given that only two plants have been documented in the state and both have been treated with the goal of eradication and it is believed that these control efforts have been successful. Mechanical methods of control like cutting and mowing are ineffective and should be avoided as the tree responds by producing large numbers of stump sprouts and root suckers, but pulling seedlings by hand (remembering that small root fragments can generate new shoots and plants) and systemic herbicides applied as foliar sprays (seedlings and small plants and suckers) and basal bark and frill herbicide applications in mid- to late summer and fall can be effective with proper technique and timing and with follow-up inspection and retreatment as needed; glyphosate and triclopyr are generally the best choices, but dicamba, imazapyr, and metsulfuron methyl are also effective (Fryer, 2010; Jackson and Gover, 2018; Rebbeck et al., 2019). Control by fire has produced mixed results with most, but not all, studies indicating that fire can increase suckering (Fryer, 2010; Rebbeck et al., 2019).***	**This text is provided as additional information not directed through the decision tree process for this particular risk assessment.**
11	Should the plant species be allowed in Minnesota via a species-specific management plan; designate as specially regulated?		

2014

Final Results of Initial Risk Assessment and Subsequent Updates		
Review Entity	**Comments**	**Outcome**
NWAC Listing Subcommittee	Eradication is possible but may not be necessary because the one known plant in MN is female and without a male plant nearby is unlikely to produce viable seed. No other plants have been found in unmanaged wooded sites in the immediate vicinity. It is unlikely that this species can currently grow well enough in MN for it to be very aggressive. However, its nationwide distribution is right on the edge of plant hardiness zone 4, and it is likely to become able to thrive and spread in MN as the climate warms. The primary concern with this would be that the species is allowed to be moved around the state for horticultural purposes in the meantime, leading to a much more widespread problem when it finally does become invasive in MN. Restricting the sale and movement of the species now will prevent future problems.	Recommended regulation of *Ailanthus altissima* (tree of heaven) as Restricted in Minnesota beginning in 2016.
NWAC Full Committee		Restricted
MDA Commissioner		Restricted

2019

Review Entity	Comments	Outcome
NWAC Listing Subcommittee	To date, the distribution of tree of heaven has been limited (only two known trees) and eradication is possible. While it is unlikely that this species can currently grow well enough in Minnesota for it to be very aggressive, with the exception of new areas of USDA Plant Hardiness Zone 5 in extreme southern Minnesota, its nationwide distribution is right on the edge of USDA Plant Cold Hardiness Zone 4, and it is possible that *Ailanthus altissima* could thrive and spread in Minnesota if the climate continues to warm. The primary concern is that if the species is allowed to be planted around the state for horticultural purposes it could lead to a much more widespread problem if changing conditions allow the species to become invasive in Minnesota. Restricting the production and sale of *Ailanthus altissima* in Minnesota now would prevent the species from becoming established as a nursery and landscape species and prevent future problems should the species become better able to survive in Minnesota in response to climate change and warmer winters.	As a result of a 2019 review and update of the tree of heaven risk assessment, recommends regulation of tree of heaven (*Ailanthus altissima*) as a Prohibited/Eradicate Noxious Weed beginning in 2020; this is a recommended change from the current listing Restricted.

Review Entity	Comments	Outcome
NWAC Committee	Vote on 12/03/19 was 15:0 in favor of Prohibited Eradicate.	Prohibited Eradicate
MDA Commissioner	Commissioner order was signed on 01/15/20 and effective on 01/17/20.	Prohibited Eradicate

Risk Assessment Summary (2019 Update): Tree of heaven (*Ailanthus altissima*) was first evaluated for potential listing as a noxious weed in Minnesota in 2014 and was subsequently listed as a Restricted Noxious Weed in 2016. Based on this 2019 review and update of the risk assessment for tree of heaven, it is recommended that *Ailanthus altissima* should continue to be regulated as a noxious weed and that its designation be changed from Restricted Noxious Weed to Prohibited/Eradicate Noxious Weed in 2020. An increase in the potential invasiveness of tree of heaven in Minnesota, and especially in southern Minnesota, in response to an increase in average winter minimum temperatures, and the role of tree of heaven as the primary host for spotted lanternfly (*Lycorma delicatula*) which could enhance the establishment and spread of this invasive and destructive insect if tree of heaven were to become established in Minnesota and should spotted lanternfly be introduced in the state, are the driving factors behind this recommendation.

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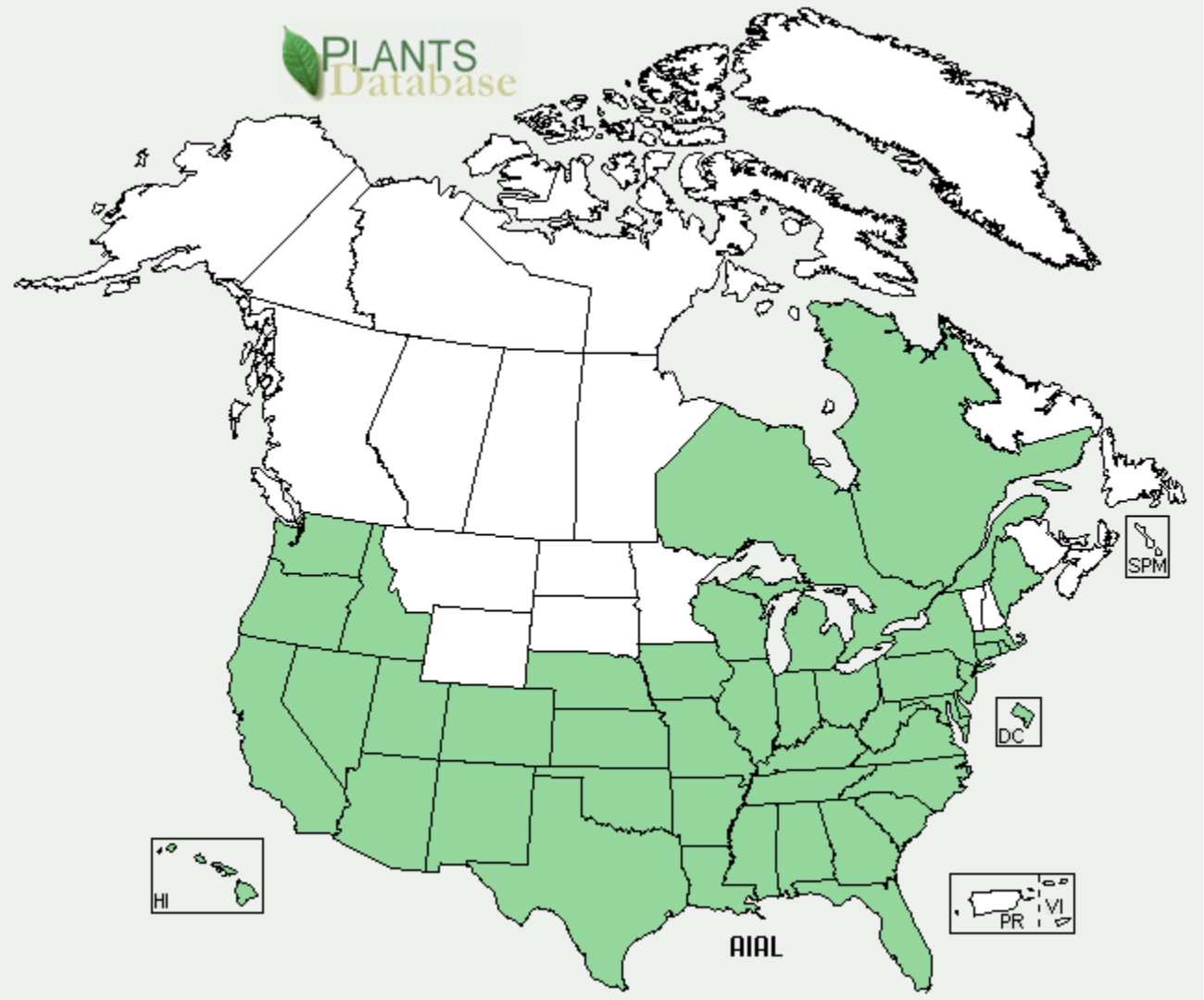
Figure 1. *Ailanthus altissima* (tree of heaven) growing in a landscape bed in St Paul, MN, in July 2014. One of only two reported findings of tree of heaven in Minnesota, the plant has spread within the bed, but the new shoots arising from root suckers have been cut back. Note the significant winter dieback. The building faces west and the tree is on the south side of a brick wall extending out from the building. As of mid-August 2014, new growth had extended as high as the dead tips shown in this photograph and there were numerous stems sprouting up throughout the landscape bed from root suckers. The tree has subsequently been eliminated (Photo Credit: Ken Graeve, MNDOT).

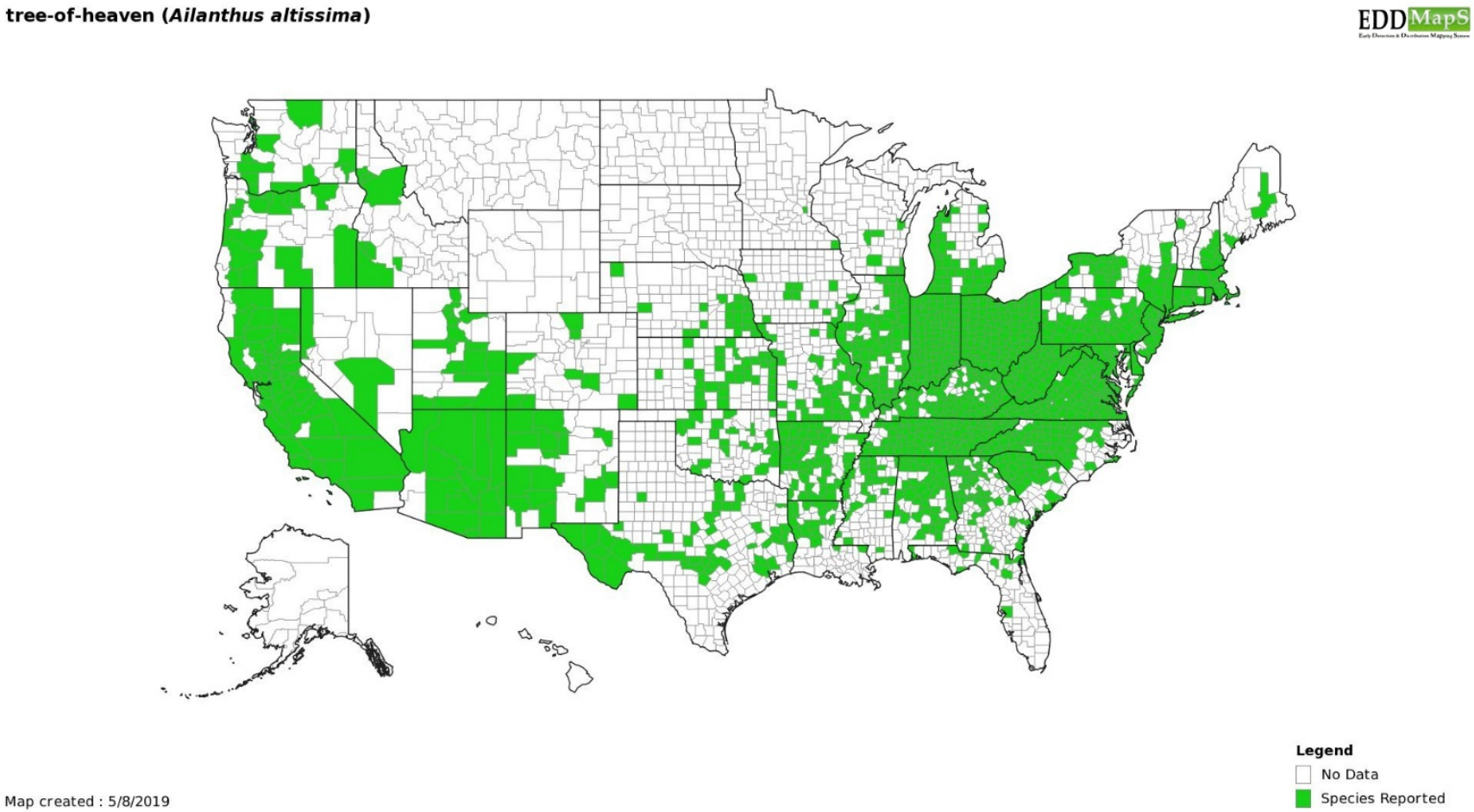
Figure 2. *Alianthus altissima* (tree of heaven) growing along Minnesota Highway 26 north of Brownsville, MN, in Houston County. The main stem was about 8" in diameter (DBH) and had several smaller root suckers that were up to 3" in diameter (DBH). The tree has been extirpated by Minnesota Department of Transportation (MNDOT) staff using a combination treatment of triclopyr and imazapyr applied as a basal bark treatment (Photo Credit: Tina Markeson, MNDOT).

Figure 3. Distribution of *Ailanthus altissima* in the United States and Canada (USDA NRCS, 2019).



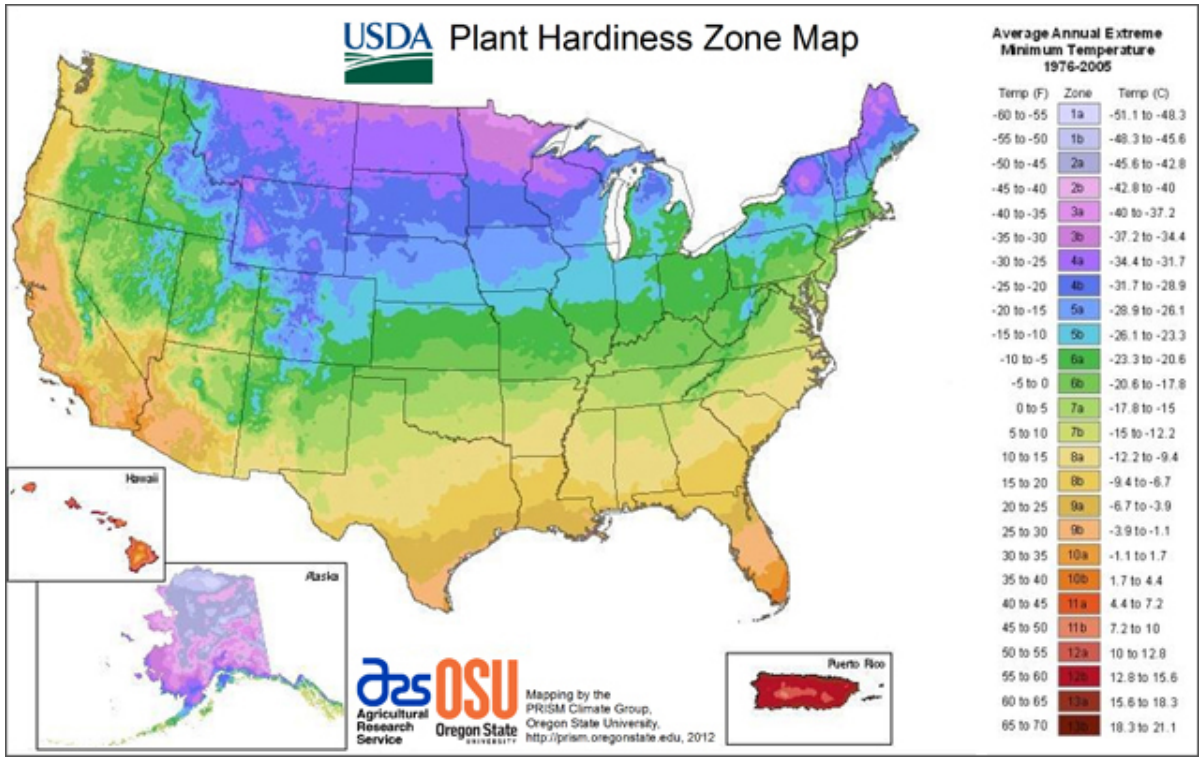
https://plants.usda.gov/core/profile?symbol=AIAL

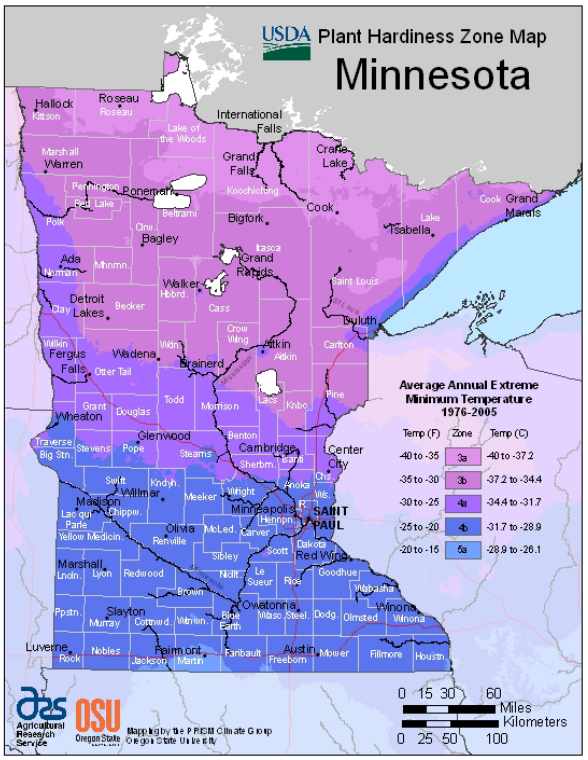
Figure 4. County Level distribution of *Ailanthus altissima* in the United States (EDDMapS, 2019).



https://www.eddmaps.org/distribution/uscounty.cfm?sub=3003

Figure 5. 2012 USDA Plant Hardiness Zones; United States and Minnesota (USDA ARS, 2012)

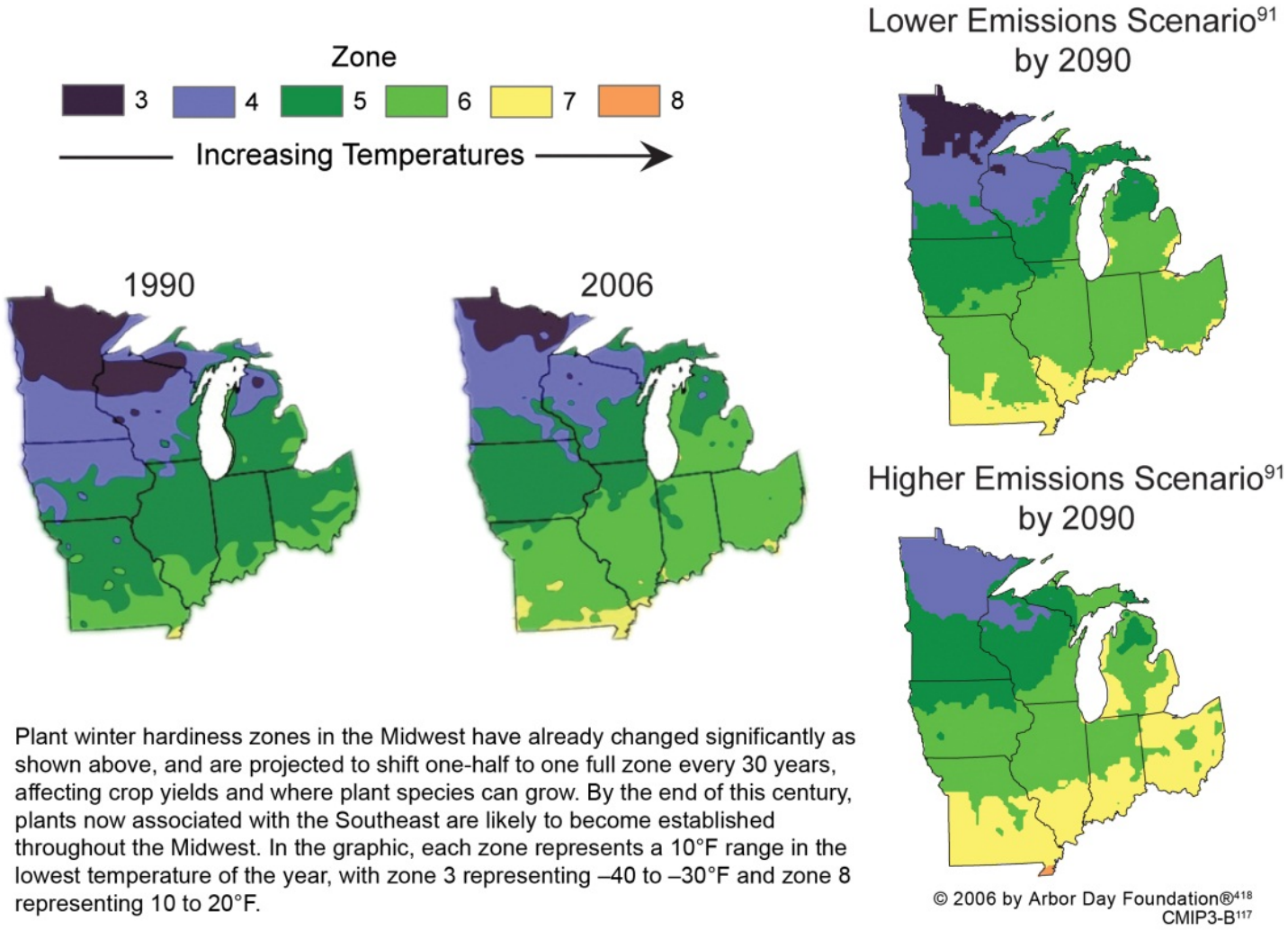




When compared to the EDDMapS distribution map, note how the county level distribution tends to follow the Zone 4/5 boundary line.

https://planthardiness.ars.usda.gov/PHZMWeb/

Figure 6. Predicted future plant hardiness zones based on climate change projections. Note how the 1990 and especially the 2006 plant hardiness zone projection maps do not correspond well with the 2012 USDA Plant Hardiness Zone map shown above (US Global Change Research Program, 2009)



Plant winter hardiness zones in the Midwest have already changed significantly as shown above, and are projected to shift one-half to one full zone every 30 years, affecting crop yields and where plant species can grow. By the end of this century, plants now associated with the Southeast are likely to become established throughout the Midwest. In the graphic, each zone represents a 10°F range in the lowest temperature of the year, with zone 3 representing –40 to –30°F and zone 8 representing 10 to 20°F.

https://nca2009.globalchange.gov/midwest/index.html