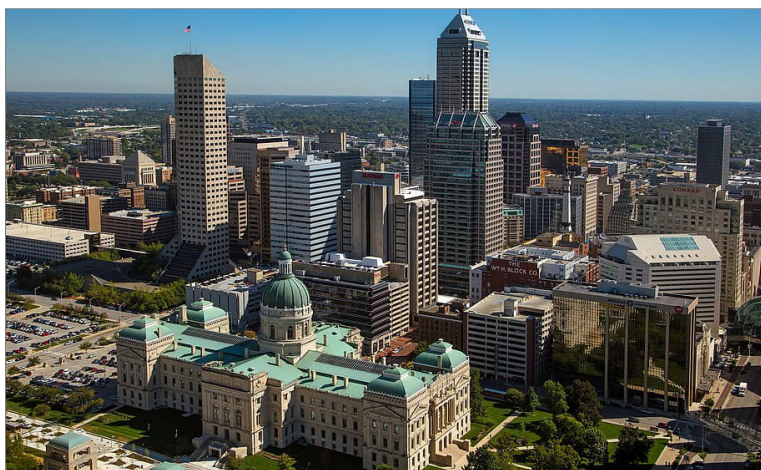


CLIMATE CHANGE VULNERABILITY OF URBAN TREES INDIANAPOLIS, INDIANA



This list was developed to aid community forestry practitioners in the greater Indianapolis area with selecting trees to reduce the climate change vulnerability of their urban forests. **This is not a recommended planting list; it is meant to be a complement to other tree selection resources.** Other factors may also need to be considered, such as aesthetics, local site conditions, wildlife value, or nursery availability. It is also important to note that *some species may have climate benefits but may not be suitable for planting for other reasons, such as having invasive potential or susceptibility to pests or pathogens.*

Vulnerability: Trees can be vulnerable to a variety of climate-related stressors such as intense heat, drought, flooding, and changing pest and disease patterns.

Climate vulnerability is a function of the impacts of climate change on a species and its adaptive capacity. Species with negative impacts on habitat suitability and low adaptive capacity will have high vulnerability and vice versa. The following factors were used to determine climate vulnerability:

Urban adaptability: Adaptability scores were generated for each species based on literature describing its tolerance to disturbances such as drought, flooding, pests, and disease, as well as its growth requirements such as shade tolerance, soil needs, and ease of nursery propagation. Scores were assigned to species using methods developed in an urban forest vulnerability assessment for Chicago for trees planted in developed sites. A positive score indicates that a species is tolerant to a wide range of disturbances and can be planted on a variety of sites. A negative score indicates a species is highly susceptible to disturbances and/or is limited to specific planting sites.

Hardiness and heat zone suitability: Tree species ranges were recorded from government, university, and arboretum websites. Species tolerance ranges were compared to current and projected heat and hardiness zones for the Indianapolis region using downscaled climate models under low emissions (RCP 4.5) and high emissions (RCP 8.5) scenarios for changes in greenhouse gases. Trees were considered to have suitable zone suitability if the species' tolerance was within the range of current and projected hardiness and heat zone through the end of the 21st century.

NOTE: This list was primarily created for species planted in developed sites, such as streets, yards, boulevards, and parks. If you are interested in projected changes in habitat suitability for native species in natural areas, see the Climate Change Tree Atlas at <https://www.fs.usda.gov/nrs/atlas/>.

Current and projected USDA Hardiness Zones and AHS Heat Zones for the Indianapolis region. Hardiness zone is determined by the average lowest temperature over a 30 year period. Heat zones are determined by the number of days above 86°F.

Time Period	Hardiness Zone Range		Heat Zone Range	
	Low Emissions	High Emissions	Low Emissions	High Emissions
1980–2010	6		5 to 6	
2010–2039	6	6	7	8
2040–2069	6	7	8	8
2070–2099	7	7	8	9

SOURCE: Adaptability scores were assigned using methods developed in an urban forest vulnerability assessment for Chicago by Brandt et al. 2017 (https://www.fs.usda.gov/nrs/pubs/gtr/gtr_nrs168.pdf). Future heat and hardiness zone information were provided from: <https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=96088b1c086a4b39b3a75d0fd97a4c40>.



URBAN ADAPTABILITY:

- + **High:** Species may perform better than modeled
- **Medium**
- **Low:** Species may perform worse than modeled

ZONE SUITABILITY:

- ✓ Suitable
- ✗ Not Suitable

VULNERABILITY:

- ▼ **Low:** Suitable zone, high adaptability
- **Low-moderate:** Suitable zone, medium adaptability
- ⊖ **Moderate:** Suitable zone, low adaptability or zone not suitable, high adaptability
- **Moderate-high:** Zone not suitable, medium adaptability
- △ **High:** Zone not suitable, low adaptability

*Invasive species **Species should be monitored due to elevated pest and disease susceptibility

COMMON NAME	ADAPT	LOW EMISSIONS		HIGH EMISSIONS		COMMON NAME	ADAPT	LOW EMISSIONS		HIGH EMISSIONS	
		ZONE SUIT	VULN	ZONE SUIT	VULN			ZONE SUIT	VULN	ZONE SUIT	VULN
Ash, Black**	-	✗	△	✗	△	Hickory, Mockernut	•	✓	●	✓	●
Ash, Green**	•	✓	●	✓	●	Hickory, Pignut	•	✓	●	✗	○
Ash, White**	-	✓	⊖	✓	⊖	Hickory, Sand	•	✓	●	✓	●
Aspen, Bigtooth	-	✗	△	✗	△	Hickory, Shagbark	•	✓	●	✗	○
Aspen, Quaking	-	✗	△	✗	△	Hickory, Shellbark	-	✓	⊖	✗	△
Baldcypress	+	✓	▼	✓	▼	Honeylocust	•	✓	●	✓	●
Basswood	•	✓	●	✗	○	Hophornbeam, American	+	✓	▼	✓	▼
Bayberry, Northern	+	✓	▼	✗	⊖	Hoptree	•	✓	●	✓	●
Beech, American**	•	✓	●	✓	●	Hornbeam, American	+	✓	▼	✓	▼
Birch, Gray	-	✗	△	✗	△	Locust, Black	•	✓	●	✓	●
Birch, Paper	•	✗	○	✗	○	Magnolia, Cucumber	+	✓	▼	✗	⊖
Birch, River	•	✓	●	✓	●	Magnolia, Star	•	✓	●	✓	●
Birch, Yellow	+	✗	⊖	✗	⊖	Magnolia, Umbrella	•	✓	●	✓	●
Blackhaw vibernum	+	✓	▼	✓	▼	Maple, Black	•	✓	●	✗	○
Boxelder	•	✓	●	✗	○	Maple, Red	•	✓	●	✓	●
Buckeye, Ohio	•	✓	●	✓	●	Maple, Silver	•	✓	●	✗	○
Buckeye, Yellow	•	✓	●	✗	○	Maple, Sugar	•	✓	●	✗	○
Butternut**	-	✗	△	✗	△	Mulberry, Red	•	✓	●	✓	●
Callery Pear*	•	✓	●	✗	○	Ninebark	+	✓	▼	✓	▼
Catalpa, Northern	-	✓	⊖	✗	△	Oak, Black	•	✓	●	✗	○
Cedar, Eastern Red	•	✓	●	✓	●	Oak, Bur	+	✓	▼	✓	▼
Cedar, White	•	✗	○	✗	○	Oak, Cherrybark	•	✓	●	✓	●
Cherry, Black	•	✓	●	✓	●	Oak, Chestnut	+	✓	▼	✗	⊖
Cherry, Pin	•	✗	○	✗	○	Oak, Chinkapin	•	✓	●	✗	○
Chestnut, American	-	✓	⊖	✗	△	Oak, Northern Pin	-	✗	△	✗	△
Chokecherry, Common	•	✓	●	✓	●	Oak, Overcup	+	✓	▼	✗	⊖
Coffeetree, Kentucky	+	✓	▼	✓	▼	Oak, Pin	•	✗	○	✗	○
Cottonwood, Eastern	+	✓	▼	✓	▼	Oak, Post	-	✓	⊖	✓	⊖
Crabapple, Prairie	•	✓	●	✓	●	Oak, Red	+	✓	▼	✓	▼
Crabapple, Wild Sweet	•	✓	●	✓	●	Oak, Scarlet	+	✓	▼	✓	▼
Dogwood, Flowering	•	✓	●	✓	●	Oak, Shingle	+	✓	▼	✗	⊖
Dogwood, Pagoda	•	✓	●	✗	○	Oak, Shumard	+	✓	▼	✓	▼
Elm, American**	•	✓	●	✓	●	Oak, Swamp Chestnut	•	✓	●	✗	○
Elm, Siberian	•	✓	●	✓	●	Oak, Swamp White	+	✓	▼	✗	⊖
Elm, Slippery	•	✓	●	✓	●	Oak, White	•	✓	●	✗	○
Elm, Winged	•	✓	●	✓	●	Osage-orange	+	✓	▼	✓	▼
Fir, Balsam	•	✗	○	✗	○	Pawpaw	•	✓	●	✗	○
Hackberry	+	✓	▼	✓	▼	Pecan	-	✓	⊖	✓	⊖
Hawthorn, Cockspur	•	✗	○	✗	○	Persimmon	+	✓	▼	✓	▼
Hawthorn, Dotted	•	✗	○	✗	○	Pine, Jack	-	✗	△	✗	△
Hawthorn, Downy	+	✗	○	✗	○	Pine, Loblolly	•	✓	●	✓	●
Hawthorn, Green	•	✗	○	✗	○	Pine, Pitch	-	✗	△	✗	△
Hemlock, Eastern**	-	✓	⊖	✗	△	Pine, Red	-	✗	△	✗	△
Hickory, Bitternut	•	✓	●	✓	●	Pine, Virginia	-	✓	⊖	✗	△
Hickory, Black	-	✓	⊖	✓	⊖	Pine, Eastern white	•	✗	○	✗	○

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		ZONE SUIT	VULN	ZONE SUIT	VULN			ZONE SUIT	VULN		
Plum, American	•	✓	●	✗	○						
Poplar, Balsam	-	✗	△	✗	△						
Redbud, Eastern	•	✓	●	✓	●						
Sassafras	•	✓	●	✓	●						
Serviceberry, Allegheny	+	✓	▼	✓	▼						
Serviceberry, Downy	-	✓	⊖	✓	⊖						
Sourwood	+	✓	▼	✓	▼						
Sugarberry	•	✓	●	✓	●						
Sweetgum	•	✓	●	✓	●						
Sycamore	•	✓	●	✓	●						
Tamarack	•	✗	○	✗	○						
Tree of heaven*	+	✓	▼	✗	⊖						
Tuliptree	-	✓	⊖	✓	⊖						
Tupelo, Black or Black Gum	+	✓	▼	✓	▼						
Walnut, Black	•	✓	●	✓	●						
Waterlocust	•	✓	●	✓	●						
Willow, Black	-	✓	⊖	✓	⊖						
Willow, Peachleaf	-	✓	⊖	✓	⊖						
Yellowwood	•	✓	●	✓	●						