CLIMATE CHANGE VULNERABILITY OF URBAN TREES

LEXINGTON, KENTUCKY

This list was developed to aid Lexington, Kentucky community forestry practitioners in selecting trees to reduce climate change vulnerability of their urban forests. 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 Lexington, Kentucky 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 www.fs.fed.us/nrs/atlas/.

Current and projected USDA Hardiness Zones and AHS Heat Zones for Lexington, Kentucky. 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	
1980–2010	6 to 7		6	
	Low Emissions	High Emissions	Low Emissions	High Emissions
2010–2039	6 to 7	7	7	7
2040–2069	7	7	8	9
2070–2099	7	8	8	10

SOURCE: *Adaptability scores were assigned using methods developed in an urban forest vulnerability assessment for Chicago by Brandt et al. 2017 (https://www.fs.fed.us/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.*

NIACS Northern Institute of Applied Climate Science

www.forestadaptation.org

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*

		LOW EMISSIONS		HIGH EMISSIONS	
COMMON NAME	ADAPT	ZONE SUIT	VULN	ZONE SUIT	VULN
Allegheny serviceberry	+	✓	▼	✓	▼
American beech	•	✓	●	✓	●
American elm	•	✓	●	✓	●
American holly	+	✓	▼	✓	▼
American linden, Basswood	•	✓	●	✗	○
American plum	•	✓	●	✗	○
American sycamore	•	✓	●	✓	●
Amur maackia	+	✗	⊖	✗	⊖
Ashe juniper	•	✓	●	✓	●
Austrian pine	•	✓	●	✗	○
Autumn brilliance serviceberry	•	✗	○	✗	○
Bald cypress*	+	✓	▼	✓	▼
Bitternut hickory	•	✓	●	✓	●
Black alder	•	✗	○	✗	○
Black cherry	–	✓	⊖	✓	⊖
Black locust	•	✓	●	✓	●
Black maple	•	✓	●	✗	○
Black oak	–	✓	⊖	✗	△
Black tupelo, Black gum	+	✓	▼	✓	▼
Black walnut	–	✓	⊖	✓	⊖
Black willow	–	✓	⊖	✓	⊖
Blackhaw	+	✓	▼	✓	▼
Blue ash	•	✓	●	✗	○
Blue spruce	•	✓	●	✗	○
Boxelder	•	✓	●	✗	○
Bur oak	+	✓	▼	✓	▼
Buttonbush	–	✓	⊖	✓	⊖
Callery pear*	•	✓	●	✗	○
Carolina silverbell	•	✓	●	✗	○
Cedar elm	+	✓	▼	✓	▼
Chestnut oak	+	✓	▼	✗	⊖
Chinese elm	+	✓	▼	✓	▼
Chinese magnolia	+	✓	▼	✓	▼
Chinkapin oak	+	✓	▼	✗	⊖
Cockspur hawthorn	•	✗	○	✗	○
Common hackberry	+	✓	▼	✓	▼
Common persimmon	+	✓	▼	✓	▼
Dawn redwood	•	✓	●	✓	●
Douglas-fir	–	✗	△	✗	△
Downy serviceberry	+	✓	▼	✓	▼
Eastern cottonwood	–	✓	⊖	✓	⊖
Eastern hemlock	–	✓	⊖	✗	△
Eastern redbud	•	✓	●	✓	●
Eastern redcedar	+	✓	▼	✓	▼
Eastern white pine	–	✗	△	✗	△

		LOW EMISSIONS		HIGH EMISSIONS	
COMMON NAME	ADAPT	ZONE SUIT	VULN	ZONE SUIT	VULN
European beech	•	✓	●	✗	○
European hornbeam	+	✓	▼	✗	⊖
European larch	•	✗	○	✗	○
Flowering dogwood	•	✓	●	✓	●
Freeman maple	+	✓	▼	✗	⊖
Ginkgo	+	✓	▼	✓	▼
Goldenrain tree*	+	✓	▼	✓	▼
Green ash	•	✓	●	✓	●
Hardy rubbertree	+	✗	⊖	✗	⊖
Hedge maple	•	✓	●	✗	○
Ironwood	+	✓	▼	✓	▼
Japanese maple	•	✗	○	✗	○
Japanese pagoda tree	+	✓	▼	✓	▼
Japanese snowbell	•	✓	●	✗	○
Japanese tree lilac	+	✗	⊖	✗	⊖
Japanese zelkova	+	✓	▼	✓	▼
Katsura tree	–	✓	⊖	✗	△
Kentucky coffeetree	+	✓	▼	✓	▼
Kousa dogwood	+	✓	▼	✗	⊖
Littleleaf linden	+	✓	▼	✗	⊖
Live oak	+	✓	▼	✓	▼
Loblolly pine	•	✓	●	✓	●
London planetree	•	✓	●	✓	●
Mockernut hickory	•	✓	●	✓	●
Musclewood	+	✓	▼	✓	▼
Northern catalpa	•	✓	●	✗	○
Northern red oak	•	✓	●	✓	●
Northern white cedar, Arborvitae	+	✗	⊖	✗	⊖
Norway maple*	+	✗	⊖	✗	⊖
Norway spruce	•	✓	●	✗	○
Ohio buckeye	•	✗	○	✗	○
Osage-orange	•	✓	●	✓	●
Overcup oak	+	✓	▼	✗	⊖
Paper birch	•	✗	○	✗	○
Pawpaw	•	✓	●	✗	○
Pecan	–	✓	⊖	✓	⊖
Persian ironwood	+	✓	▼	✗	⊖
Pignut hickory	•	✓	●	✗	○
Pin oak	•	✗	○	✗	○
Pitch pine	–	✗	△	✗	△
Post oak	•	✓	●	✓	●
Red maple	•	✓	●	✓	●
Red mulberry	•	✓	●	✓	●
River birch	•	✓	●	✓	●
Rusty blackhaw	•	✓	●	✗	○

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*

		LOW EMISSIONS		HIGH EMISSIONS	
COMMON NAME	ADAPT	ZONE SUIT	VULN	ZONE SUIT	VULN
Sassafras	•	✔	●	✔	●
Sawtooth oak*	+	✔	▼	✕	⊖
Scarlet oak	•	✔	●	✔	●
Scots pine	•	✕	○	✕	○
Shagbark hickory	–	✔	⊖	✕	△
Shellbark hickory	–	✔	⊖	✕	△
Shingle oak	+	✔	▼	✕	⊖
Shortleaf pine	–	✔	⊖	✔	⊖
Shumard oak	•	✔	●	✔	●
Silver maple	•	✔	●	✕	○
Slippery elm	•	✔	●	✔	●
Southern magnolia	+	✔	▼	✔	▼
Southern red oak	•	✔	●	✕	○
Sugar maple	•	✔	●	✕	○
Sugarberry	•	✔	●	✔	●
Swamp chestnut oak	•	✔	●	✔	●
Swamp white oak	+	✔	▼	✕	⊖
Sweetbay magnolia	•	✔	●	✔	●
Sweetgum	–	✔	⊖	✔	⊖
Tatarian maple	•	✕	○	✕	○
Tree of heaven*	+	✔	▼	✕	⊖
Tuliptree	–	✔	⊖	✔	⊖
Turkish hazelnut	+	✕	⊖	✕	⊖
Virginia pine	–	✔	⊖	✕	△
White ash	–	✔	⊖	✔	⊖
White fir	•	✕	○	✕	○
White fringetree	+	✔	▼	✔	▼
White mulberry*	•	✔	●	✕	○
White oak	–	✔	⊖	✕	△
White spruce	•	✕	○	✕	○
Willow oak	+	✔	▼	✔	▼
Winter king green hawthorn	•	✕	○	✕	○
Witchhazel	•	✔	●	✕	○
Yellow buckeye	•	✔	●	✕	○
Yellowwood	+	✔	▼	✔	▼