CLIMATE CHANGE VULNERABILITY OF URBAN TREES

PHOENIX, ARIZONA

This list was developed to aid Phoenix, Arizona 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 Chicago, Illinois 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 Phoenix, Arizona. 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	9		11	
	Low Emissions	High Emissions	Low Emissions	High Emissions
2010–2039	9	9	11	11 to 12
2040–2069	9	9 to 10	11	12
2070–2099	9 to 10	10	11 to 12	12

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*

COMMON NAME	ADAPT	LOW EMISSIONS ZONE SUIT	LOW EMISSIONS VULN	HIGH EMISSIONS ZONE SUIT	HIGH EMISSIONS VULN
Afghan Pine	•	✓	●	✓	●
Aleppo Pine	•	✓	●	✓	●
Alligator Bark Juniper	•	✓	●	✗	○
Alpine Fir	•	✗	○	✗	○
Anacacho Orchid	•	✓	●	✓	●
Apricot	•	✗	○	✗	○
Arizona Ash	•	✓	●	✓	●
Arizona Cypress	•	✗	○	✗	○
Arizona Rosewood	•	✓	●	✓	●
Arizona Sycamore	•	✓	●	✗	○
Arizona Walnut	•	✓	●	✓	●
Arizona White Oak	•	✓	●	✓	●
Athel Tree	•	✗	○	✗	○
Australian Bottle	•	✓	●	✓	●
Australian Willow	•	✓	●	✓	●
Bigtooth Maple	+	✗	⊖	✗	⊖
Birch Leaf Mountain Mahogany	+	✓	▼	✓	▼
Bitter Condalia	–	✓	⊖	✓	⊖
Black Locust	•	✗	○	✗	○
Blackbrush Acacia	•	✓	●	✓	●
Blue Elderberry	•	✗	○	✗	○
Bue Jacaranda	•	✓	●	✗	○
Blue Leaf Wattle	•	✓	●	✓	●
Blue Oak	•	✗	○	✗	○
Blue Palo Verde	•	✓	●	✓	●
Blue Spruce	+	✗	⊖	✗	⊖
Boxelder	•	✗	○	✗	○
Brazilian Pepper	•	✓	●	✓	●
Bristlecone Pine	•	✗	○	✗	○
California Fan Palm	•	✓	●	✓	●
California Pepper	•	✓	●	✓	●
Callery Pear*	•	✗	○	✗	○
Canary Island Pine	•	✓	●	✓	●
Canyon Hackberry	•	✓	●	✗	○
Canyon Live Oak	•	✓	●	✓	●
Carob	•	✓	●	✓	●
Cascalote	•	✓	●	✓	●
Catclaw Acacia	•	✓	●	✓	●
Chaste Tree	+	✗	⊖	✗	⊖
Chestnut Oak	+	✗	⊖	✗	⊖
Chihuahua Pine	•	✓	●	✓	●
Chihuahuan Orchid	•	✓	●	✓	●
Chilean Mesquite	•	✓	●	✓	●
Chinaberry	•	✓	●	✓	●
Chinese Banyan	•	✓	●	✓	●
Chinese Elm	+	✗	⊖	✗	⊖
Chinese Pistache	+	✓	▼	✗	⊖
Chinkapin Oak	•	✗	○	✗	○
Chitalpa	+	✓	▼	✗	⊖
Coast Live Oak	•	✓	●	✗	○
Common Fig	–	✗	△	✗	△
Coolibah	•	✓	●	✓	●
Coral Gum	•	✓	●	✓	●
Cottonwood	–	✗	△	✗	△
Crapemyrtle	+	✓	▼	✗	⊖
Crucifixion Thorn	•	✓	●	✓	●
Curl-Leaf Mountain Mahogany	+	✗	⊖	✗	⊖
Dense Longwood	•	✓	●	✓	●
Desert Hackberry	+	✓	▼	✗	⊖
Desert Ironwood	•	✓	●	✓	●
Desert Museum Palo Verde	•	✓	●	✗	○
Desert Willow	•	✓	●	✓	●
Douglas Fir	–	✗	△	✗	△
Edible Apple Tree	•	✗	○	✗	○
Emory Oak	•	✗	○	✗	○
Empress, Princess Tree*	+	✗	⊖	✗	⊖
Engelmann Spruce	•	✗	○	✗	○
Fan-Tax Ash	•	✓	●	✓	●
Featherbush, Desert Fern	•	✓	●	✓	●
Foothill Palo Verde	–	✓	⊖	✓	⊖
Foothill Pine	–	✓	⊖	✓	⊖
Fremont Cottonwood	•	✓	●	✗	○
Fruitless Olive, Wilson Olive	•	✗	○	✗	○
Gambel Oak	•	✗	○	✗	○
Ghost Gum	•	✓	●	✓	●
Globe Willow	•	✓	●	✗	○
Golden Leadball	•	✓	●	✗	○
Guajillo	•	✗	○	✗	○
Guayacan	•	✓	●	✓	●
Honey Locust*	•	✗	○	✗	○
Honey Mesquite	•	✓	●	✓	●
Hong Kong Orchid	•	✓	●	✓	●
Indian Bean Tree	•	✗	○	✗	○
Indian Rosewood, Sissoo	•	✓	●	✓	●
Italian Cypress	•	✓	●	✗	○
Jerusalem Thorn	+	✓	▼	✓	▼
Jojoba Bush	•	✓	●	✓	●
Leather-leaf Acacia	•	✓	●	✓	●
Lemon Tree	•	✓	●	✓	●
Limber Pine	+	✗	⊖	✗	⊖

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
Littleleaf Ash	+	✓	▼	✓	▼
London Planetree	•	✗	○	✗	○
Mastic Tree	+	✓	▼	✓	▼
Mediterranean Fan Palm	+	✓	▼	✗	○
Mescal Bean	+	✓	▼	✓	▼
Mexican Bird of Paradise	•	✓	●	✓	●
Mexican Blue Palm	•	✓	●	✓	●
Mexican Buckeye	+	✓	▼	✓	▼
Mexican Ebony	•	✓	●	✓	●
Mexican Fan Palm	•	✓	●	✓	●
Mexican Pinyon	•	✗	○	✗	○
Mexican Redbud	–	✓	⊖	✗	△
Mexican Sycamore	•	✓	●	✗	○
Montezuma Bald Cypress	•	✓	●	✓	●
Mulga	+	✓	▼	✓	▼
Netleaf White Oak	+	✓	▼	✓	▼
New Mexico Locust	+	✗	⊖	✗	⊖
New Mexico Olive	+	✓	▼	✗	⊖
Oleander	+	✓	▼	✓	▼
Olive	•	✗	○	✗	○
One Seed Juniper	+	✗	⊖	✗	⊖
Orange	•	✓	●	✓	●
Palo Blanco, Willard Acacia	•	✓	●	✓	●
Palo Brea, Sonoran Palo Verde	•	✓	●	✓	●
Paper Mulberry	•	✓	●	✗	○
Peach	•	✗	○	✗	○
Pecan	–	✓	⊖	✗	△
Peruvian Pepper	•	✓	●	✓	●
Pin Oak	•	✗	○	✗	○
Pinyon Pine	+	✗	⊖	✗	⊖
Pomegranate	•	✓	●	✓	●
Ponderosa Pine	–	✗	△	✗	△
Purple Orchid	•	✓	●	✓	●
Purple-leaf Plum, Cherry Plum	•	✗	○	✗	○
Pygmy Date Palm	•	✓	●	✓	●
Quaking Aspen	+	✗	⊖	✗	⊖
Raywood Ash	•	✗	○	✗	○
Red Alder	–	✓	●	✓	●
Red Bottlebrush	•	✓	●	✓	●
Red Mulberry	•	✗	○	✗	○
Red Oak	•	✗	○	✗	○
Red Push Pistache	+	✓	▼	✓	▼
Red-cap Gum	•	✓	●	✓	●
Redberry Juniper	•	✓	●	✓	●
River Tamarind	•	✓	●	✓	●

		LOW EMISSIONS		HIGH EMISSIONS	
COMMON NAME	ADAPT	ZONE SUIT	VULN	ZONE SUIT	VULN
Rocky Mountain Juniper	+	✗	⊖	✗	⊖
Rocky Mountain Maple	+	✗	⊖	✗	⊖
Russian Olive*	+	✗	⊖	✗	⊖
Saguaro Cactus	•	✓	●	✓	●
Santa Rosa Plum	•	✗	○	✗	○
Schaffner Acacia, Twisted Acacia	•	✓	●	✓	●
Screwbean Mesquite	+	✓	▼	✓	▼
Scrub Oak	•	✗	○	✗	○
Shamel Ash, Evergreen Ash	•	✓	●	✓	●
Shoestring Acacia	+	✓	▼	✓	▼
Siberian Elm*	•	✗	○	✗	○
Silk Tree	–	✓	⊖	✗	△
Silverleaf Oak	•	✓	●	✓	●
Singleleaf Pinyon	+	✗	⊖	✗	⊖
Southern Live Oak	+	✓	▼	✓	▼
Southwestern White Pine	+	✓	▼	✗	⊖
Sweet Acacia	–	✓	⊖	✓	⊖
Tamarisk Evergreen	+	✗	⊖	✗	⊖
Tenaza	•	✓	●	✓	●
Texas Ebony	•	✓	●	✓	●
Texas Kidneywood	•	✓	●	✓	●
Texas Live Oak	–	✓	⊖	✓	⊖
Texas Mountain Laurel	+	✓	▼	✓	▼
Texas Olive	–	✓	⊖	✓	⊖
Texas Red Oak	•	✓	●	✓	●
Tipu	•	✓	●	✓	●
Utah Juniper	•	✗	○	✗	○
Velvet Mesquite	•	✓	●	✓	●
Waxy Privet, Japanese Privet	•	✗	○	✗	○
Weeping Bottlebrush	•	✓	●	✗	○
Weeping Fig	•	✓	●	✓	●
Weeping Mycall	•	✓	●	✓	●
Weeping Willow	•	✗	○	✗	○
Western Chokecherry	•	✗	○	✗	○
Western Redbud	+	✓	▼	✗	⊖
Western Soapberry	•	✗	○	✗	○
White Fir	•	✗	○	✗	○
White Mulberry	•	✗	○	✗	○
Whitethorn Acacia	+	✓	▼	✓	▼
Willow Acacia	•	✓	●	✓	●
Yellow Elder	•	✓	●	✓	●
Yellow Oleander	+	✓	▼	✓	▼