Phoenix Region: Climate and Health Tree Species List

The Climate and Health Tree Species List was developed for the Phoenix, Arizona region to visualize some of the climate and health benefits and concerns when selecting tree species and aid community forestry practitioners in selecting trees. The list is not considered a recommended planting list but demonstrates the complexity of tree species selection and provides insight into four categories: climate vulnerability, carbon benefit, health benefit, and health disservices. Note that the tree species included in this list are limited by the available tree species data within i-Tree.

Climate Vulnerability

Trees can be vulnerable to various climate-related stressors such as heat, drought, flooding, and pest and disease patterns. Climate vulnerability is a function of climate change impacts on a tree species and the species' adaptive capacity. Species that are projected to have 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:

- **Habitat Suitability:** Habitat suitability was determined by examining heat and hardiness zone ranges. The ranges were documented for each tree species and compared with current and projected heat and hardiness zones for Phoenix, Arizona using downscaled climate models.
- **Adaptability:** To understand the capacity of tree species and cultivars in the area to adapt to these other effects of climate change, we relied on a scoring system developed by Matthews et al. (2011) and methods developed in an urban forest vulnerability assessment for Chicago (Brandt et al. 2017). Each tree species was assessed for adaptability based on literature describing its tolerance to biological factors such as soil needs, shade tolerance, maintenance requirements, and nursery propagation, as well as disturbance factors such as drought, flooding, pests, and disease.

Carbon Benefit

Trees store carbon in their wood, roots, and leaves and help reduce energy use for heating and cooling. Carbon benefits provided by each tree species were modeled for Phoenix, Arizona using i-Tree data (i-Tree Team, n.d.) and were binned into categories based on their relative carbon benefits to one another. The following factors were used to assess carbon benefits:

- **Carbon Storage:** The total of all carbon stored during the average lifespan of a tree species. Smaller trees tend to store less carbon, while larger trees tend to store more carbon.
- **Carbon Sequestration Rate:** The carbon absorption of a tree species per year. Species that have more growth per year will have higher carbon sequestration rates.
- **Carbon Savings from Energy Use:** The total amount of carbon saved from reduced heating and cooling energy use. Large conifer trees tend to reduce heating energy use, and large shade trees tend to reduce cooling energy use.

Health Benefit

Trees can reduce risks to human health such as heat stress and reduced air quality, which can increase under a changing climate. Trees provide shade and cooling through transpiration, as well as absorption of pollutants. Human health benefits provided by each tree species were modeled for Phoenix, Arizona using i-Tree data (i-Tree Team, n.d.) and were binned into categories based on their relative health benefits to one another. The following factors were used to assess human health benefits:

- **Leaf Area:** The maximum leaf area reached over a tree species' lifespan. Trees with greater leaf area provide more shade and tend to absorb more pollutants.
- **Transpiration:** The average transpiration rate per year. The rate can be influenced by tree size as well as differences in water-use efficiency. Tree species that transpire more tend to be better at evaporative cooling and flood mitigation.

- **Pollutants Removed:** The weighted sum of pollutants NO_3, O_3, $PM_{2.5}$, and SO_2 removed over a tree species' lifespan.

Health Disservices

Some trees can have negative effects on human health by producing allergenic pollen or volatile organic compounds such as isoprene or monoterpenes, which can reduce air quality. Isoprene and monoterpene emissions for each tree species were modeled for Phoenix, Arizona using i-Tree data (i-Tree Team, n.d.) and were binned into categories based on their relative health disservices to one another. Allergenicity for each tree species was determined from Pollen Library (IMC Health, 2022), which bins each tree species into an allergenicity category (none, low, moderate, severe). The following factors were used to assess health disservices:

- **Allergenicity:** The capacity of a tree species to cause an allergic reaction. Trees that are wind-pollinated tend to be more allergenic.
- **Isoprene Emissions:** The total emissions of isoprene compounds over a tree species' lifespan. Some tree species (particularly broadleaved trees such as oaks) can be high emitters of isoprene.
- **Monoterpene Emissions:** The total emissions of monoterpene compounds over a tree species' lifespan. Some tree species (particularly many conifers) can be high emitters of monoterpenes.

Table 1.—Climate and health tree species list for Phoenix, Arizona.

Scientific Name	Common Name	Climate Vulnerability – Low Climate Change Scenario	Climate Vulnerability – High Climate Change Scenario	Carbon Benefit	Health Benefit	Health Disservices
Abies concolor	White Fir	Moderate-high	Moderate-high	Low-moderate	Low-moderate	Low-moderate
Abies lasiocarpa	Alpine Fir	Moderate-high	Moderate-high	Low	Low-moderate	Low-moderate
Acacia saligna	Blue Leaf Wattle	Low-moderate	Low-moderate	Low	Low-moderate	Moderate
Acer negundo	Boxelder	Moderate-high	Moderate-high	Moderate-high	High	High
Albizia julibrissin	Silk Tree	Moderate	High	Low	Low-moderate	Moderate
Alnus rubra	Red Alder	Low-moderate	Low-moderate	Low	Moderate-high	Moderate-high
Brachychiton populneus	Australian Bottle	Low-moderate	Low-moderate	Moderate	Moderate-high	Low
Carya illinoinensis	Pecan	Moderate	High	Low-moderate	Low-moderate	Moderate-high
Catalpa bignonioides	Indian Bean Tree	Moderate-high	Moderate-high	Low-moderate	Moderate	Low-moderate
Citrus × limon	Lemon Tree	Low-moderate	Low-moderate	Low	Low	Low
Cupressus arizonica	Arizona Cypress	Moderate-high	Moderate-high	Moderate-high	Low-moderate	Moderate-high
Cupressus sempervirens	Italian Cypress	Low-moderate	Moderate-high	Low	Low	Moderate-high
Elaeagnus angustifolia	Russian Olive	Moderate	Moderate	Low	Low	Low-moderate
Ficus benjamina	Weeping Fig	Low-moderate	Low-moderate	Low	Low-moderate	Moderate-high
Fraxinus velutina	Arizona Ash	Low-moderate	Low-moderate	Low-moderate	Low-moderate	Moderate
Gleditsia triacanthos	Honey Locust	Moderate-high	Moderate-high	Low-moderate	Low-moderate	Low
Jacaranda mimosifolia	Blue Jacaranda	Low-moderate	Moderate-high	Low-moderate	Moderate	Low
Juglans major	Arizona Walnut	Low-moderate	Low-moderate	Low-moderate	Moderate	Moderate-high
Juniperus osteosperma	Utah Juniper	Moderate-high	Moderate-high	Low	Moderate	Moderate
Juniperus scopulorum	Rocky Mountain Juniper	Moderate	Moderate	Moderate	Moderate	Moderate
Lagerstroemia indica	Crapemyrtle	Low	Moderate	Low	Low	Low

Scientific Name	Common Name	Climate Vulnerability – Low Climate Change Scenario	Climate Vulnerability – High Climate Change Scenario	Carbon Benefit	Health Benefit	Health Disservices
Malus domestica	Edible Apple Tree	Moderate-high	Moderate-high	Low	Low	Moderate
Melia azedarach	Chinaberry	Low-moderate	Low-moderate	Low-moderate	Low-moderate	Moderate
Morus alba	White Mulberry	Moderate-high	Moderate-high	Low	Moderate	Moderate-high
Morus rubra	Red Mulberry	Moderate-high	Moderate-high	Low	Moderate	Moderate-high
Olea europaea	Olive	Moderate-high	Moderate-high	Moderate	Moderate	Moderate-high
Olneya tesota	Desert Ironwood	Low-moderate	Low-moderate	Low	Low	Moderate
Paulownia tomentosa	Empress, Princess Tree	Moderate	Moderate	Low-moderate	High	Low
Picea engelmannii	Engelmann Spruce	Moderate-high	Moderate-high	Low-moderate	Moderate	Low-moderate
Picea pungens	Blue spruce, Colorado spruce, Silver spruce	Moderate	Moderate	Moderate	Moderate	Low-moderate
Pinus aristata	Bristlecone Pine	Moderate-high	Moderate-high	Low-moderate	Low-moderate	Low-moderate
Pinus canariensis	Canary Island Pine	Low-moderate	Low-moderate	Moderate	Low-moderate	Low-moderate
Pinus cembroides	Mexican pinyon	Moderate-high	Moderate-high	Low	Low	Low-moderate
Pinus edulis	Pinyon Pine (Piñon)	Moderate	Moderate	Low	Low-moderate	Low-moderate
Pinus eldarica	Afghan Pine	Low-moderate	Low-moderate	Moderate	Low	Low-moderate
Pinus flexilis	Limber Pine	Moderate	Moderate	Low-moderate	Low	Low-moderate
Pinus halepensis	Aleppo Pine	Low-moderate	Low-moderate	Low-moderate	Moderate	Low-moderate
Pinus leiophylla, var chihuahua	Chihuahua pine	Low-moderate	Low-moderate	Low-moderate	Low	Low-moderate
Pinus monophylla	Singleleaf Pinyon	Moderate	Moderate	Low-moderate	Moderate	Low-moderate
Pinus ponderosa	Ponderosa Pine	High	High	Low-moderate	Low	Low-moderate
Pinus sabiniana	Foothill Pine	Moderate	Moderate	Moderate-high	Low	Low-moderate
Pinus strobiformis	Southwestern White Pine	Low	Moderate	High	Low	Low-moderate
Pistacia chinensis	Chinese Pistache	Low	Moderate	Low	Low-moderate	Low
Platanus × acerifolia	London Planetree	Moderate-high	Moderate-high	Moderate	Moderate-high	Moderate-high
Platanus wrightii	Arizona Sycamore	Low-moderate	Moderate-high	Moderate-high	High	Moderate-high
Populus deltoides	Cottonwood	High	High	Moderate-high	Moderate	Moderate-high
Populus fremontii	Fremont Cottonwood, Western Cottonwood	Low-moderate	Moderate-high	High	Moderate	Moderate-high
Populus tremuloides	Quaking Aspen	Moderate	Moderate	Moderate-high	Moderate-high	Moderate-high
Prosopis chilensis	Chilean Mesquite	Low-moderate	Low-moderate	Low	Low	Low-moderate
Prosopis glandulosa	Honey Mesquite	Low-moderate	Low-moderate	Low	Low	Low-moderate
Prunus armeniaca	Apricot	Moderate-high	Moderate-high	Low	Low-moderate	Low-moderate
Prunus cerasifera	Purple-leaf Plum, Cherry Plum	Moderate-high	Moderate-high	Low	Moderate	Low-moderate
Prunus persica	Peach	Moderate-high	Moderate-high	Low	Moderate	Low-moderate
Prunus virginiana	Western Chokecherry (Chokecherry)	Moderate-high	Moderate-high	Low	Moderate	Low-moderate
Pseudotsuga menziesii	Douglas-Fir	High	High	Low-moderate	Low	Low
Pyrus calleryana	Callery Pear	Moderate-high	Moderate-high	Moderate	Moderate	Low-moderate

Scientific Name	Common Name	Climate Vulnerability – Low Climate Change Scenario	Climate Vulnerability – High Climate Change Scenario	Carbon Benefit	Health Benefit	Health Disservices
Quercus agrifolia	Coast Live Oak	Low-moderate	Moderate-high	Moderate-high	Low-moderate	High
Quercus chrysolepis	Canyon Live Oak	Low-moderate	Low-moderate	Moderate-high	Low-moderate	High
Quercus douglasii	Blue Oak	Moderate-high	Moderate-high	Moderate	Low-moderate	High
Quercus gambelii	Gambel Oak (Rocky Mountain White Oak)	Moderate-high	Moderate-high	Low	Low-moderate	High
Quercus montana, Quercus prinus	Chestnut Oak	Moderate	Moderate	Moderate-high	Moderate	High
Quercus muehlenbergii	Chinkapin Oak	Moderate-high	Moderate-high	Moderate	Low	High
Quercus palustris	Pin Oak	Moderate-high	Moderate-high	Moderate	High	High
Quercus rubra	Red Oak	Moderate-high	Moderate-high	Moderate-high	Low-moderate	High
Quercus virginiana	Southern Live Oak	Low	Low	Low-moderate	Low-moderate	High
Robinia neomexicana	New Mexico Locust	Moderate	Moderate	Low	Low-moderate	Moderate
Robinia pseudoacacia	Black Locust	Moderate-high	Moderate-high	Moderate	Low	Moderate
Salix matsudana	Globe Willow	Low-moderate	Moderate-high	Moderate	Moderate-high	High
Sapindus saponaria var. drummondii	Western Soapberry	Moderate-high	Moderate-high	Low	Low-moderate	Low
Schinus molle	California Pepper	Low-moderate	Low-moderate	Low	Low	Low-moderate
Taxodium mucronatum	Montezuma Bald Cypress	Low-moderate	Low-moderate	High	Low-moderate	Low
Ulmus parvifolia	Chinese Elm	Moderate	Moderate	High	Low-moderate	Moderate
Ulmus pumila	Siberian Elm	Moderate-high	Moderate-high	High	Moderate	Moderate
Washingtonia filifera	California Fan Palm	Low-moderate	Low-moderate	Low	Low-moderate	Low-moderate
Washingtonia robusta	Mexican Fan Palm	Low-moderate	Low-moderate	Low	Low-moderate	Low-moderate

References

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