

Climate and Health Species List for Rhode Island Urban Trees

This list was developed to aid Rhode Island community forestry practitioners in selecting trees to reduce climate change vulnerability, reduce carbon dioxide in the atmosphere, and provide benefits to human health. 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 and health benefits but may not be suitable for planting for other reasons, such as having invasive potential or susceptibility to pests or pathogens.



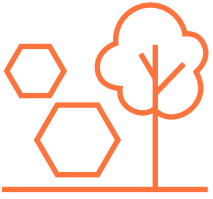
Climate Vulnerability

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:

- **Hardiness and heat zone tolerance:** 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 Rhode Island using downscaled climate models.¹
- **Habitat suitability modeling projections:** Modeled projections for native species were summarized from the [Climate Change Atlas](#) website under low and high emissions for the 1-degree latitude/longitude grid cell that covers Rhode Island (east of 71W and south of 41N).²⁻⁴
- **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 Rhode Island species using methods developed in an urban forest vulnerability assessment for Chicago.⁵

Current and projected USDA Hardiness Zones and AHS Heat Zones for the state of Rhode Island.¹ 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 - Rhode Island		Heat Zone Range - Rhode Island	
	Low emissions	High emissions	Low emissions	High emissions
1980–2009	6 to 7		2 to 4	
2010–2039	6 to 7	7	3 to 5	4 to 6
2040–2069	7	7 to 8	4 to 6	6 to 8
2070–2099	7	8	4 to 6	8 to 9



Carbon

Trees provide benefits by reducing greenhouse gases in the atmosphere by directly storing carbon in their leaves, wood, and roots, and by helping to reduce energy use for heating and cooling. Benefits provided by each species were modeled for the city of Providence, RI and binned into categories based on their relative carbon benefits to one another using methods developed for the [i-Tree Species Selector](#).⁶ The following factors were combined to assess carbon benefits:

- **Carbon storage:** the total of all carbon stored during the average lifespan for the species. Larger trees tend to store more carbon.
- **Carbon sequestration rate:** carbon absorption per year. Species that gain a lot of growth per year will have higher sequestration rates.
- **Carbon savings from energy use:** the total amount of carbon saved from reduced heating and cooling energy use. Large shade trees tend to reduce cooling energy use and large conifers tend to reduce heating energy use.



Human health

Trees can reduce risks to human health that may be faced under a changing climate, such as heat stress and reduced air quality, by providing shade, cooling through transpiration, and absorption of pollutants. Benefits provided by each species were modeled for the city of Providence, RI and binned into categories based on their relative health benefits to one another using methods developed for the [i-Tree Species Selector](#).⁶ The following factors were combined to assess human health benefits:

- **Leaf area:** the maximum leaf area reached over the species' lifespan. Trees with greater leaf area provide more shade and can typically absorb more pollutants.
- **Transpiration:** average transpiration rate per year, which is influenced in part by tree size and differences in water use efficiency. Trees that transpire more can be better at evaporative cooling and mitigating flooding.
- **Pollutants removed:** weighted sum of the pollutants NO_3 , O_3 , $\text{PM}_{2.5}$ and SO_2 removed over a species' lifespan.

Some trees may need to be considered for their potential negative effects on human health. In particular, some trees produce allergenic pollen or volatile organic compounds such as isoprene or monoterpenes that can reduce air quality. Isoprene and monoterpene emissions for each species were modeled for the city of Providence, RI and binned into categories based on their relative health benefits to one another using methods developed for the [i-Tree Species Selector](#).⁶ Allergenicity was based on Ogren Plant Allergy Scale.⁷ The following factors were combined to assess human health disservices:

- **Allergenicity:** how likely the tree is to cause allergies. Wind-pollinated trees tend to be more allergenic.
- **Isoprene emissions:** total emissions of isoprene over a species' lifespan. Certain species of broadleaved trees, such as oaks, are known for high isoprene emissions.
- **Monoterpene emissions:** total emissions of monoterpenes over a species' lifespan. Some species, and many conifers in particular, can be high emitters of monoterpenes.

LEGEND



low





































































moderate



high



Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
<i>Abies balsamea</i>	Balsam fir					
<i>Acer campestre</i>	Hedge maple					can be invasive
<i>Acer ginnala</i>	Amur maple					can be invasive
<i>Acer griseum</i>	Paperbark maple					
<i>Acer negundo</i>	Boxelder					can be invasive
<i>Acer palmatum</i>	Japanese maple					can be invasive
<i>Acer platanoides</i>	Norway maple					can be invasive
<i>Acer pseudoplatanus</i>	Sycamore maple					can be invasive
<i>Acer rubrum</i>	Red maple					
<i>Acer saccharinum</i>	Silver maple					
<i>Acer saccharum</i>	Sugar maple					
<i>Acer tartaricum</i>	Tatarian maple		n/a	n/a		
<i>Acer truncatum</i>	Shantung maple					

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
<i>Acer x freemanii</i>	Freeman maple		n/a	n/a		
<i>Aesculus hippocastanum</i>	Horse chestnut					can be invasive
<i>Aesculus x carnea</i>	Red horsechestnut					
<i>Ailanthus altissima</i>	Tree of heaven					can be invasive
<i>Amelanchier canadensis</i>	Shadblow/ Canadian serviceberry					
<i>Amelanchier laevis</i>	Serviceberry					
<i>Albizia julibrissin</i>	Mimosa/silk tree					
<i>Betula alleghaniensis</i>	Yellow birch					significant pest/ disease issues
<i>Betula lenta</i>	Sweet birch					
<i>Betula nigra</i>	River birch					
<i>Betula papyrifera</i>	Paper birch					significant pest/ disease issues
<i>Betula pendula</i>	Silver birch					significant pest/ disease issues, can be invasive
<i>Betula populifolia</i>	Gray birch					significant pest/ disease issues
<i>Carpinus betulus</i>	European hornbeam					
<i>Carpinus caroliniana</i>	American hornbeam					
<i>Carya alba</i>	Mockernut hickory					
<i>Carya cordiformis</i>	Bitternut hickory					

LEGEND



low



moderate



high

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
<i>Carya glabra</i>	Pignut hickory					
<i>Carya ovata</i>	Shagbark hickory					
<i>Carya texana</i>	Black hickory					
<i>Catalpa bignonioides</i>	Southern catalpa					
<i>Celtis laevigata</i>	Sugarberry					
<i>Celtis occidentalis</i>	Hackberry					
<i>Cercidiphyllum japonicum</i>	Katsura tree					
<i>Cercis canadensis</i>	Eastern redbud					
<i>Chamaecyparis thyoides</i>	Atlantic white-cedar					
<i>Cladrastis kentukea</i>	Yellowwood					
<i>Cornus florida</i>	Flowering dogwood					significant pest/disease issues
<i>Cornus kousa</i>	Kousa dogwood					
<i>Corylus colurna</i>	Turkish filbert					

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
<i>Crataegus crus-galli</i> var. <i>inermis</i>	Thornless cockspur hawthorn					significant pest/disease issues
<i>Cryptomeria japonica</i>	Japanese cedar					
<i>Diospyros virginiana</i>	Common persimmon					
<i>Eucommia ulmoides</i>	Hardy rubber tree					
<i>Fagus grandifolia</i>	American beech					significant pest/disease issues
<i>Fagus sylvatica</i>	European beech					significant pest/disease issues
<i>Fraxinus americana</i>	White ash					significant pest/disease issues
<i>Fraxinus pennsylvanica</i>	Green ash					significant pest/disease issues
<i>Ginkgo biloba</i>	Ginkgo					
<i>Gleditsia triacanthos</i> var. <i>inermis</i>	Honeylocust					
<i>Gymnocladus dioica</i>	Kentucky coffeetree					
<i>Ilex opaca</i>	American holly					
<i>Juglans nigra</i>	Black walnut					
<i>Juniperus virginiana</i>	Eastern redcedar					
<i>Koelreuteria paniculata</i>	Golden raintree					
<i>Laburnum x watereri</i>	Golden chain tree		n/a	n/a		
<i>Larix decidua</i>	European larch					

LEGEND



low



moderate



high

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
<i>Liquidambar styraciflua</i>	Sweetgum					
<i>Liriodendron tulipifera</i>	Tulip tree					
<i>Maackia amurensis</i>	Amur maakia					
<i>Metasequoia glyptostroboides</i>	Dawn redwood					
<i>Nyssa sylvatica</i>	Black tupelo					
<i>Ostrya virginiana</i>	Hop-hornbeam					
<i>Oxydendrum arboreum</i>	Sourwood					
<i>Parrotia persica</i>	Persian ironwood					
<i>Picea abies</i>	Norway spruce					can be invasive
<i>Picea pungens</i>	Blue spruce					significant pest/disease issues
<i>Pinus echinata</i>	Shortleaf pine					significant pest/disease issues
<i>Pinus resinosa</i>	Red pine					significant pest/disease issues
<i>Pinus rigida</i>	Pitch pine					significant pest/disease issues

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
<i>Pinus strobus</i>	White pine					
<i>Pinus sylvestris</i>	Scots pine					significant pest/disease issues
<i>Pinus taeda</i>	Loblolly pine					significant pest/disease issues
<i>Pinus virginiana</i>	Virginia pine					significant pest/disease issues
<i>Platanus x acerifolia</i>	London planetree					
<i>Platanus occidentalis</i>	American sycamore					
<i>Populus balsamifera</i>	Balsam poplar					
<i>Populus deltoides</i>	Eastern cottonwood					prone to structural failure
<i>Populus grandidentata</i>	Bigtooth aspen					
<i>Populus tremuloides</i>	Quaking aspen					
<i>Prunus cerasifera</i>	Flowering plum					significant pest/disease issues, prone to structural failure
<i>Prunus padus</i>	Bird cherry		n/a	n/a		
<i>Prunus pensylvanica</i>	Pin cherry		n/a	n/a		
<i>Prunus sargentii</i>	Sargent cherry					
<i>Prunus serotina</i>	Black cherry					
<i>Prunus serrulata</i> 'Kwanzan'	Kwanzan cherry					
<i>Prunus virginiana</i> 'Schubert'	Schubert cherry					

LEGEND



low



































































moderate



high



Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
<i>Prunus x yedoensis</i>	Yoshino cherry					
<i>Pyrus calleryana</i>	Callery pear					can be invasive, prone to structural failure
<i>Quercus acutissima</i>	Sawtooth oak					
<i>Quercus alba</i>	White oak					
<i>Quercus bicolor</i>	Swamp white oak					
<i>Quercus coccinea</i>	Scarlet oak					
<i>Quercus falcata</i>	Southern red oak					
<i>Quercus imbricaria</i>	Shingle oak					
<i>Quercus macrocarpa</i>	Bur oak					
<i>Quercus marilandica</i>	Blackjack oak					
<i>Quercus michauxii</i>	Swamp chestnut oak					
<i>Quercus nigra</i>	Water oak					
<i>Quercus palustris</i>	Pin oak					

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
<i>Quercus phellos</i>	Willow oak					
<i>Quercus prinus</i>	Chestnut oak					
<i>Quercus robur</i>	English oak					can be invasive
<i>Quercus rubra</i>	Northern red oak					
<i>Quercus stellata</i>	Post oak					
<i>Quercus velutina</i>	Black oak					
<i>Robinia pseudoacacia</i>	Black locust					can be invasive
<i>Sassafras albidum</i>	Sassafras					
<i>Sciadopitys verticillata</i>	Japanese umbrella pine		n/a	n/a		
<i>Sorbus alnifolia</i>	Korean mountain ash					
<i>Sorbus americana</i>	American mountain ash					significant pest/disease issues
<i>Styphnolobium japonicum</i>	Sophora/Japanese pagoda					
<i>Styrax japonicus</i>	Japanese snowbell					
<i>Syringa reticulata</i>	Japanese tree lilac		n/a	n/a		
<i>Taxodium distichum</i>	Bald cypress					
<i>Tilia americana</i>	American basswood					
<i>Tilia cordata</i>	Littleleaf linden					

LEGEND



low



moderate



high



Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
<i>Tilia tomentosa</i>	Silver linden					
<i>Tilia x euchlora</i>	Caucasian linden					
<i>Tsuga canadensis</i>	Eastern hemlock					significant pest/disease issues
<i>Ulmus alata</i>	Winged elm					
<i>Ulmus americana</i>	American elm					significant pest/disease issues
<i>Ulmus 'Homestead'</i>	Homestead elm		n/a			can be invasive
<i>Ulmus parvifolia</i>	Chinese elm					can be invasive
<i>Zelkova serrata</i>	Japanese zelkova					

Information Sources:

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3. Peters, M.P., Iverson, L.R., Prasad, A.M. and Matthews, S.N., 2019. Utilizing the density of inventory samples to define a hybrid lattice for species distribution models: DISTRIB-II for 135 eastern US trees. *Ecology and evolution*, 9(15), pp.8876-8899.
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Funding Sources:

Funding for this product generously provided by the Doris Duke Charitable Foundation, part of a broader investment to optimize urban forests for climate and public health outcomes.

