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	
1980–2009	6 to 7		2 to 4	
	Low emissions	High emissions	Low emissions	High emissions
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
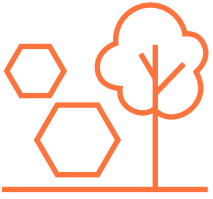
Carbon

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, PM2.5 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 monoterpences 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
Abies balsamea	Balsam fir	three-quarter	half	three-quarter	half	
Acer campestre	Hedge maple	low	low	low	half	can be invasive
Acer ginnala	Amur maple	high	quarter	three-quarter	half	can be invasive
Acer griseum	Paperbark maple	half	low	quarter	three-quarter	
Acer negundo	Boxelder	three-quarter	half	half	half	can be invasive
Acer palmatum	Japanese maple	quarter	low	low	three-quarter	can be invasive
Acer platanoides	Norway maple	half	three-quarter	high	three-quarter	can be invasive
Acer pseudoplatanus	Sycamore maple	half	high	high	half	can be invasive
Acer rubrum	Red maple	half	high	high	three-quarter	
Acer saccharinum	Silver maple	half	half	three-quarter	three-quarter	
Acer saccharum	Sugar maple	quarter	three-quarter	high	three-quarter	
Acer tartaricum	Tatarian maple	three-quarter	n/a	n/a	half	
Acer truncatum	Shantung maple	half	low	low	three-quarter	

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
Acer x freemanii	Freeman maple	¼	n/a	n/a	½	
Aesculus hippocastanum	Horse chestnut	¼	¼	full	empty	can be invasive
Aesculus x carnea	Red horsechenut	empty	empty	¼	empty	
Ailanthus altissima	Tree of heaven	empty	½	empty	empty	can be invasive
Amelanchier canadensis	Shadblow/ Canadian serviceberry	¾	empty	empty	empty	
Amelanchier laevis	Serviceberry	empty	empty	¼	empty	
Albizia julibrissin	Mimosa/silk tree	½	empty	empty	½	
Betula alleghaniensis	Yellow birch	½	½	¾	¼	significant pest/ disease issues
Betula lenta	Sweet birch	¼	¼	½	¼	
Betula nigra	River birch	¼	¼	½	¼	
Betula papyrifera	Paper birch	¾	¼	½	¼	significant pest/ disease issues
Betula pendula	Silver birch	¾	¼	¼	½	significant pest/ disease issues, can be invasive
Betula populifolia	Gray birch	¾	empty	empty	¼	significant pest/ disease issues
Carpinus betulus	European hornbeam	empty	¼	¼	¼	
Carpinus caroliniana	American hornbeam	empty	empty	¼	½	
Carya alba	Mockernut hickory	empty	¾	¾	¾	
Carya cordiformis	Bitternut hickory	¼	½	¾	¾	

LEGEND

low   moderate   high

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

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
Crataegus crus-galli var. inermis	Thornless cockspur hawthorn	½	○	¼	○	significant pest/ disease issues
Cryptomeria japonica	Japanese cedar	○	○	●	½	
Diospyros virginiana	Common persimmon	○	○	○	○	
Eucommia ulmoides	Hardy rubber tree	½	¼	¼	½	
Fagus grandifolia	American beech	¼	¾	●	¼	significant pest/ disease issues
Fagus sylvatica	European beech	½	½	●	¼	significant pest/ disease issues
Fraxinus americana	White ash	½	¾	¼	¼	significant pest/ disease issues
Fraxinus pennsylvanica	Green ash	¼	●	●	¼	significant pest/ disease issues
Ginkgo biloba	Ginkgo	○	¼	¾	¼	
Gleditsia triacanthos var. inermis	Honeylocust	¼	¾	¼	○	
Gymnocladus dioicus	Kentucky coffeetree	○	○	○	○	
Ilex opaca	American holly	○	○	½	○	
Juglans nigra	Black walnut	¼	●	●	¾	
Juniperus virginiana	Eastern redcedar	○	○	¼	½	
Koelreuteria paniculata	Golden raintree	○	○	¼	○	
Laburnum x watereri	Golden chain tree	¼	n/a	n/a	○	
Larix decidua	European larch	¾	½	¾	½	

LEGEND

low ○ ◔ ◑ moderate ◕ ● high

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

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
Pinus strobus	White pine	full	full	full	half	
Pinus sylvestris	Scots pine	3/4	3/4	3/4	half	significant pest/disease issues
Pinus taeda	Loblolly pine	1/4	3/4	3/4	half	significant pest/disease issues
Pinus virginiana	Virginia pine	half	half	half	half	significant pest/disease issues
Platanus x acerifolia	London planetree	1/4	3/4	full	1/4	
Platanus occidentalis	American sycamore	1/4	full	full	1/4	
Populus balsamifera	Balsam poplar	full	3/4	3/4	1/4	
Populus deltoides	Eastern cottonwood	half	half	half	half	prone to structural failure
Populus grandidentata	Bigtooth aspen	full	3/4	3/4	half	
Populus tremuloides	Quaking aspen	full	3/4	empty	half	
Prunus cerasifera	Flowering plum	1/4	empty	empty	empty	significant pest/disease issues, prone to structural failure
Prunus padus	Bird cherry	1/4	n/a	n/a	empty	
Prunus pensylvanica	Pin cherry	full	n/a	n/a	empty	
Prunus sargentii	Sargent cherry	half	empty	3/4	empty	
Prunus serotina	Black cherry	half	3/4	half	empty	
Prunus serrulata 'Kwanzan'	Kwanzan cherry	1/4	empty	empty	empty	
Prunus virginiana 'Schubert'	Schubert cherry	3/4	empty	empty	empty	

LEGEND

low — moderate — high

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

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
Quercus phellos	Willow oak	○ (empty)	● (full)	● (full)	◕ (¾)	
Quercus prinus	Chestnut oak	○ (empty)	◐ (½)	◐ (½)	◕ (¾)	
Quercus robur	English oak	◔ (¼)	◕ (¾)	● (full)	● (full)	can be invasive
Quercus rubra	Northern red oak	◔ (¼)	● (full)	◕ (¾)	● (full)	
Quercus stellata	Post oak	◐ (½)	◐ (½)	◐ (½)	◕ (¾)	
Quercus velutina	Black oak	◔ (¼)	◐ (½)	◔ (¼)	● (full)	
Robinia pseudoacacia	Black locust	◔ (¼)	○ (empty)	○ (empty)	◐ (½)	can be invasive
Sassafras albidum	Sassafras	◔ (¼)	◐ (½)	◐ (½)	○ (empty)	
Sciadopitys verticillata	Japanese umbrella pine	◔ (¼)	n/a	n/a	◐ (½)	
Sorbus alnifolia	Korean mountain ash	◐ (½)	◔ (¼)	◔ (¼)	○ (empty)	
Sorbus americana	American mountain ash	◐ (½)	○ (empty)	◔ (¼)	○ (empty)	significant pest/ disease issues
Styphnolobium japonicum	Sophora/ Japanese pagoda	◐ (½)	○ (empty)	◔ (¼)	○ (empty)	
Styrax japonicus	Japanese snowbell	◔ (¼)	○ (empty)	○ (empty)	○ (empty)	
Syringa reticulata	Japanese tree lilac	◐ (½)	n/a	n/a	○ (empty)	
Taxodium distichum	Bald cypress	○ (empty)	● (full)	● (full)	◐ (½)	
Tilia americana	American basswood	◔ (¼)	◔ (¼)	◐ (½)	◔ (¼)	
Tilia cordata	Littleleaf linden	◐ (½)	◔ (¼)	◐ (½)	◔ (¼)	

LEGEND

low — moderate — high

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

Information Sources:

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