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	◕	◑	◕	◑	
Acer campestre	Hedge maple	○	○	○	◑	can be invasive
Acer ginnala	Amur maple	◕	◔	◕	◑	can be invasive
Acer griseum	Paperbark maple	◑	○	◔	◕	
Acer negundo	Boxelder	◕	◑	◑	◑	can be invasive
Acer palmatum	Japanese maple	◔	○	○	◕	can be invasive
Acer platanoides	Norway maple	◑	◕	●	◕	can be invasive
Acer pseudoplatanus	Sycamore maple	◑	●	●	◑	can be invasive
Acer rubrum	Red maple	◑	●	●	◕	
Acer saccharinum	Silver maple	◑	◑	◕	◕	
Acer saccharum	Sugar maple	◔	◕	●	◕	
Acer tartaricum	Tatarian maple	◕	n/a	n/a	◑	
Acer truncatum	Shantung maple	◔	○	○	◕	

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

LEGEND

○	◔	◑	◕	●
low		moderate		high

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

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

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	●	●	●	◑	
Pinus sylvestris	Scots pine	◕	◕	◕	◑	significant pest/ disease issues
Pinus taeda	Loblolly pine	◔	◕	◕	◑	significant pest/ disease issues
Pinus virginiana	Virginia pine	◑	◑	◑	◑	significant pest/ disease issues
Platanus x acerifolia	London planetree	◔	◕	●	◔	
Platanus occidentalis	American sycamore	◔	●	●	◑	
Populus balsamifera	Balsam poplar	●	◕	◕	◑	
Populus deltoides	Eastern cottonwood	◑	◑	◑	◑	prone to structural failure
Populus grandidentata	Bigtooth aspen	●	◔	◔	◑	
Populus tremuloides	Quaking aspen	●	◔	○	◑	
Prunus cerasifera	Flowering plum	◔	○	○	○	significant pest/disease issues, prone to structural failure
Prunus padus	Bird cherry	◔	n/a	n/a	○	
Prunus pensylvanica	Pin cherry	●	n/a	n/a	○	
Prunus sargentii	Sargent cherry	◑	○	◔	○	
Prunus serotina	Black cherry	◑	◕	◑	○	
Prunus serrulata 'Kwanzan'	Kwanzan cherry	◔	○	○	○	
Prunus virginiana 'Schubert'	Schubert cherry	◕	○	○	○	

LEGEND

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

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

LEGEND

○	◔	◑	◕	●
low		moderate		high

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

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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.