Climate and Health Species List for Rhode Island Urban Trees

The tree species list for Rhode Island was compiled to show some of the types of benefits or concerns when selecting trees to reduce climate change vulnerability, reduce carbon dioxide in the atmosphere, and provide benefits to human health. It is meant to show the complexity of tree selection but should not be considered a recommended species list. Other factors not included in this list may also be important to species selection in forested areas, such as native species benefits, species natural ranges, site conditions, and goals. Urban and landscape decisions may also need to consider "right tree, right place", site conditions, moisture availability, and root space. While this list can show some species with identified climate and health benefits, this is not the complete list of choices available for RI and may not be suitable for planting for your specific site or needs. Contact your State Stewardship Forester for species recommendations for natural areas and your State Urban Forester for recommendations for urban areas.

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.

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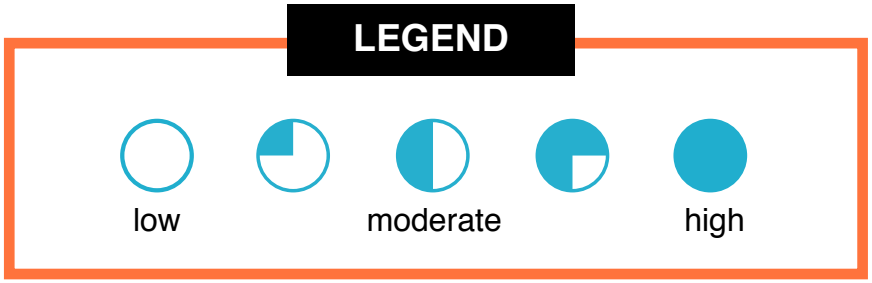
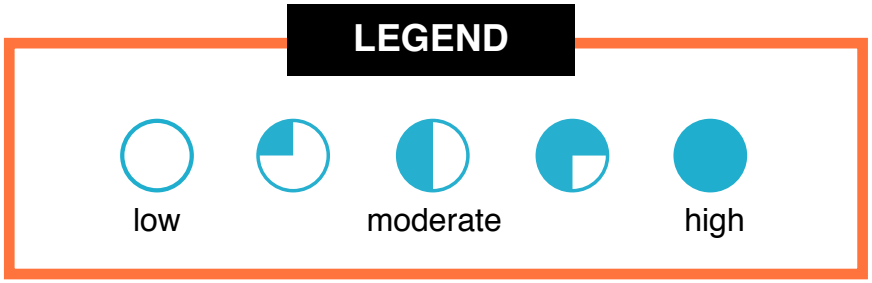
Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
Acer campestre	Hedge maple					can be invasive
Acer ginnala	Amur maple					can be invasive
Acer griseum	Paperbark maple					
Acer negundo	Boxelder					can be invasive
Acer rubrum	Red maple					
Acer saccharinum	Silver maple					
Acer saccharum	Sugar maple					
Acer tartaricum	Tatarian maple		n/a	n/a		
Acer truncatum	Shantung maple					
Acer x freemanii	Freeman maple		n/a	n/a		
Aesculus hippocastanum	Horse chestnut					can be invasive
Aesculus x carnea	Red horsechestnut					
Amelanchier canadensis	Shadblow/ Canadian serviceberry					

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
Amelanchier laevis	Serviceberry					
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					
Carya glabra	Pignut hickory					
Carya ovata	Shagbark hickory					
Celtis laevigata	Sugarberry					
Celtis occidentalis	Hackberry					
Cercidiphyllum japonicum	Katsura tree					
Cercis canadensis	Eastern redbud					



Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
Chamaecyparis thyoides	Atlantic white-cedar					
Cladrastis kentukea	Yellowwood					
Cornus florida	Flowering dogwood					significant pest/ disease issues
Cornus kousa	Kousa dogwood					
Corylus colurna	Turkish filbert					
Crataegus crus-galli var. inermis	Thornless cockspur hawthorn					significant pest/ disease issues
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
Ginkgo biloba	Ginkgo					
Gleditsia triacanthos var. inermis	Honeylocust					
Gymnocladus dioicus	Kentucky coffeetree					

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
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		
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					
Pinus resinosa	Red pine					significant pest/ disease issues
Pinus strobus	White pine					
Pinus sylvestris	Scots pine					significant pest/ disease issues



Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
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 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 sargentii	Sargent cherry					
Prunus serotina	Black cherry					
Prunus serrulata 'Kwanzan'	Kwanzan cherry					
Prunus virginiana 'Schubert'	Schubert cherry					
Quercus alba	White oak					

Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
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					
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					
Sassafras albidum	Sassafras					
Sorbus alnifolia	Korean mountain ash					

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Scientific Name	Common Name	Climate Vulnerability	Carbon Benefit	Health Benefit	Health Disservices	Notes
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					
Tilia tomentosa	Silver linden					
Tilia x euchlora	Caucasian linden					
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					

Information Sources:

1. USDA Office of Sustainability and Climate (2018). Climate Change Pressures in the 21st Century. Retrieved from https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=96088b1c086a4b39b3a75d0fd97a4c40.

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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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