

# Boston Region Urban Trees: Climate, Carbon, and Health

This list was compiled to show some of the types of benefits and 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 inform tree selection, but should not be considered a recommended species list.** Urban and landscape planting decisions must consider native species benefits, natural and future ranges under climate change, “right tree, right place” growing site conditions related to soil type, moisture availability and root space, and overall site goals. While this list identifies some species with climate and health benefits, or low climate vulnerability and low health disservices, it is not a comprehensive list of species available for the Boston Region.

Certain species may or may not be suitable for planting for your specific site or needs. **Species that are considered invasive and species that have elevated pest and disease susceptibility are identified with asterisks.** Other considerations you may wish to discuss with an urban forestry professional include: species size and longevity, branching and rooting habits, wildlife and pollinator benefits, and encouraging species diversity. Contact the [Massachusetts Department of Conservation and Recreation Urban and Community Forestry program](#) for further guidance on area specific species recommendations and other urban and community forestry topics.



## 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 the Boston region using downscaled climate models.<sup>1</sup>
- **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 the Boston region (east of 71 & 70W and south of 42N).<sup>2-4</sup>
- **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 Boston region species using methods developed in an urban forest vulnerability assessment for Chicago.<sup>5</sup>

Current and projected USDA Hardiness Zones and AHS Heat Zones for the Boston region. 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 - Boston Region		Heat Zone Range - Boston Region	
	Low emissions	High emissions	Low emissions	High emissions
1980–2009	6 to 7		4	
2010–2039	6 to 7	7	5	6
2040–2069	7	8	6	7 to 8
2070–2099	7	8 to 9	6 to 7	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](#).<sup>6</sup> 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](#).<sup>6</sup> 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  $\text{NO}_3$ ,  $\text{O}_3$ ,  $\text{PM}_{2.5}$  and  $\text{SO}_2$  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](#).<sup>6</sup> Allergenicity was based on Ogren Plant Allergy Scale.<sup>7</sup> 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.

Scientific Name	Common Name	Climate Vulnerability	Health Disservices	Carbon Benefit	Health Benefit
<i>Abies balsamea</i>	Balsam fir	Moderate-high	Low-moderate	Low	Low-moderate
<i>Abies concolor</i>	White fir	Moderate-high	Low-moderate	Low	Low-moderate
<i>Acer buergerianum</i>	Trident maple	Low-moderate	Moderate-high	Low	Low-moderate
<i>Acer campestre</i>	Hedge maple	Moderate-high	Moderate-high	Low	Low-moderate
<i>Acer griseum</i>	Paperbark maple	High	Moderate-high	Low	Low-moderate
<i>Acer pensylvanicum</i>	Striped maple	Moderate-high	Moderate-high	Low	Low-moderate
<i>Acer platanoides</i>	Norway maple	Moderate	Moderate-high	Moderate	Low-moderate
<i>Acer rubrum</i>	Red maple	Low-moderate	Moderate-high	High	Moderate
<i>Acer saccharinum</i>	Silver maple	Low-moderate	Moderate-high	Moderate-high	Moderate
<i>Acer saccharum</i>	Sugar maple	Moderate-high	Moderate-high	Moderate-high	Low-moderate
<i>Acer tataricum ginnala*</i>	Amur maple*	Moderate-high	Low-moderate	Low	Moderate
<i>Acer truncatum</i>	Shantung maple, Purpleblow maple	Moderate	Moderate-high	Low	Low-moderate
<i>Aesculus hippocastanum</i>	European horsechestnut	Moderate-high	Moderate	Moderate-high	Moderate
<i>Aesculus x carnea</i>	Red horsechestnut	Low-moderate	Moderate	High	Low-moderate
<i>Amelanchier laevis</i>	Allegheny serviceberry	Low	Low	Low	Low
<i>Asimina triloba</i>	Pawpaw	Low-moderate	Low	Low	Low-moderate
<i>Betula alleghaniensis</i>	Yellow birch	Moderate	Moderate	Moderate-high	Moderate
<i>Betula lenta</i>	Sweet birch	Moderate-high	Moderate	High	Moderate
<i>Betula nigra</i>	River birch	Low-moderate	Moderate	Moderate-high	Moderate
<i>Betula papyrifera</i>	Paper birch	Moderate-high	Moderate	Moderate	High

**Important considerations key:**

\*Invasive species \*\*Species has elevated pest and disease susceptibility

Scientific Name	Common Name	Climate Vulnerability	Health Disservices	Carbon Benefit	Health Benefit
<i>Betula populifolia</i>	Gray birch	High	Moderate	Low	Moderate
<i>Carpinus betulus</i>	Common hornbeam, European hornbeam	Moderate	Moderate	Low	Low-moderate
<i>Carpinus caroliniana</i>	Musclewood, American hornbeam	Low	Moderate	Low	Low-moderate
<i>Carya cordiformis</i>	Bitternut hickory	Low-moderate	Moderate-high	Moderate	Moderate-high
<i>Carya glabra</i>	Pignut hickory	Low-moderate	Moderate-high	Moderate	Moderate-high
<i>Carya illinoensis</i>	Pecan	Moderate	Moderate-high	Moderate	Low-moderate
<i>Carya laciniosa</i>	Shellbark hickory	Moderate	Moderate-high	Moderate	Moderate
<i>Carya ovata</i>	Shagbark hickory	Moderate-high	Moderate-high	Moderate	Moderate
<i>Carya texana</i>	Black hickory	Moderate	Moderate-high	Moderate-high	Moderate
<i>Castanea dentata</i>	American chestnut	High	Moderate	Moderate	Moderate
<i>Catalpa speciosa</i>	Northern catalpa	High	Low-moderate	Moderate	Low-moderate
<i>Celtis laevigata</i>	Sugarberry	Low-moderate	Moderate	Low	Low-moderate
<i>Celtis occidentalis</i>	Common hackberry	Low	Moderate	Low	Moderate
<i>Cercidiphyllum japonicum</i>	Katsura tree	High	Moderate-high	Low-moderate	Moderate-high
<i>Cercis canadensis</i>	Eastern redbud	Moderate-high	Low-moderate	Low-moderate	Low-moderate
<i>Chamaecyparis thyoides</i>	Atlantic white cedar	Moderate	Moderate	Low	Moderate
<i>Chionanthus virginicus</i>	White fringetree	Low	Low-moderate	Low	Low-moderate
<i>Cladrastis kentukea</i>	Yellowwood	Moderate-high	Low-moderate	Moderate	Low-moderate
<i>Cornus florida</i>	Flowering dogwood	Low-moderate	Low-moderate	Low	Low

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<i>Cornus kousa</i>	Kousa dogwood	Moderate	Moderate	Low	Low
<i>Cornus mas</i>	Cornelian cherry dogwood	Moderate-high	Low-moderate	Low	Low
<i>Corylus colurna</i>	Turkish filbert	Moderate-high	Low-moderate	High	Moderate
<i>Cotinus obovatus</i>	American smoketree	Moderate-high	Low	Low	Low
<i>Crataegus crus-galli</i>	Cockspur hawthorn	Moderate-high	Low-moderate	Low	Low
<i>Crataegus laevigata</i>	English hawthorn	Moderate-high	Low-moderate	Low	Low
<i>Crataegus monogyna</i>	Common hawthorn	Moderate-high	Low-moderate	Low	Low
<i>Diospyros virginiana</i>	Common persimmon	Low	Low-moderate	Moderate	Low
<i>Eucommia ulmoides</i>	Hardy Rubber Tree	Moderate	Low-moderate	Moderate	Moderate
<i>Fagus grandifolia</i> **	American beech**	Low-moderate	Low-moderate	Moderate-high	Moderate-high
<i>Fraxinus americana</i>	White ash	Moderate	Moderate	High	Low-moderate
<i>Fraxinus pennsylvanica</i> **	Green ash**	Low-moderate	Moderate	Moderate	Moderate
<i>Ginkgo biloba</i>	Ginkgo	Low	Moderate	Low-moderate	Moderate
<i>Gleditsia triacanthos</i> *	Honeylocust*	Moderate-high	Low	Moderate	Low-moderate
<i>Gymnocladus dioicus</i>	Kentucky coffeetree	Moderate	Low	Low-moderate	Low-moderate
<i>Halesia tetraptera</i> , <i>Halesia carolina</i>	Carolina silverbell	Moderate-high	Low	Low	Moderate
<i>Ilex opaca</i>	American holly	Low	Low	Low	Moderate
<i>Juglans cinerea</i> **	Butternut**	High	Low	Low-moderate	Moderate
<i>Juglans nigra</i>	Black walnut	Low-moderate	Moderate-high	Moderate	Moderate
<i>Juniperus virginiana</i>	Eastern redcedar	Low-moderate	Moderate-high	Low	Moderate
<i>Koelreuteria paniculata</i> *	Goldenrain tree*	Low	Low-moderate	Moderate	Low-moderate

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Scientific Name	Common Name	Climate Vulnerability	Health Disservices	Carbon Benefit	Health Benefit
<i>Liquidambar styraciflua</i>	Sweetgum	Low-moderate	Moderate	Moderate	Moderate
<i>Liriodendron tulipifera</i>	Tuliptree	Moderate	Low-moderate	Moderate-high	High
<i>Maackia amurensis</i>	Amur maackia	Moderate	Moderate	Moderate	Low
<i>Maclura pomifera</i>	Osage-orange	Low	Low-moderate	Low	Low-moderate
<i>Magnolia acuminata</i>	Cucumbertree	Moderate	Moderate	High	Moderate
<i>Magnolia virginiana</i>	Sweet bay magnolia	Moderate-high	Moderate	High	Low-moderate
<i>Malus sylvestris</i>	Crabapple	Moderate-high	Moderate	Moderate	Moderate
<i>Metasequoia glyptostroboides</i>	Dawn redwood	Low-moderate	Low	Low-moderate	Moderate
<i>Morus rubra</i>	Red mulberry	Low-moderate	Moderate-high	Low	Moderate
<i>Nyssa sylvatica</i>	Black tupelo, Black gum	Low	Moderate	High	Moderate
<i>Ostrya virginiana</i>	Ironwood	Low	Low-moderate	Low-moderate	Moderate
<i>Oxydendrum arboreum</i>	Sourwood	Low	Low-moderate	Low	Low
<i>Parrotia persica</i>	Persian ironwood	Moderate	Moderate-high	Low	Low-moderate
<i>Picea abies</i> *	Norway spruce*	Moderate-high	Low-moderate	Low-moderate	Moderate-high
<i>Picea glauca</i>	White spruce	Moderate-high	Low-moderate	Low-moderate	Moderate
<i>Picea omorika</i>	Serbian spruce	Moderate-high	Low-moderate	High	Moderate-high
<i>Picea rubens</i>	Red spruce	Moderate-high	Low-moderate	Moderate	Moderate
<i>Pinus cembra</i>	Swiss stone pine	Moderate	Low-moderate	Moderate-high	Low-moderate
<i>Pinus clausa</i>	Sand pine	Moderate	Low-moderate	Low-moderate	Low-moderate
<i>Pinus echinata</i>	Shortleaf pine	Moderate	Low-moderate	Low-moderate	Low-moderate
<i>Pinus palustris</i>	Longleaf pine	Low-moderate	Low-moderate	Low-moderate	Low-moderate

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Scientific Name	Common Name	Climate Vulnerability	Health Disservices	Carbon Benefit	Health Benefit
<i>Pinus resinosa</i>	Red pine	High	Low-moderate	Moderate	Low-moderate
<i>Pinus rigida</i>	Pitch pine	High	Low-moderate	Moderate	Low-moderate
<i>Pinus serotina</i>	Pond pine	Moderate	Low-moderate	Low-moderate	Low-moderate
<i>Pinus strobus</i>	Eastern white pine	Moderate-high	Low-moderate	Low-moderate	Moderate
<i>Pinus taeda</i>	Loblolly pine	Low-moderate	Low-moderate	Moderate	High
<i>Pinus virginiana</i>	Virginia pine	High	Low-moderate	Moderate	Low-moderate
<i>Plantanus x acerifolia</i>	London planetree	Moderate-high	Low-moderate	Moderate-high	High
<i>Platanus occidentalis</i>	American sycamore	Low-moderate	Low-moderate	Moderate	High
<i>Populus deltoides</i>	Eastern cottonwood	Low	Moderate-high	High	Moderate
<i>Populus grandidentata</i>	Bigtooth aspen	High	Moderate-high	High	Moderate
<i>Populus tremuloides</i>	Quaking aspen	High	Moderate-high	Moderate-high	Moderate-high
<i>Prunus persica</i>	Peach	Low-moderate	Low-moderate	Moderate	Moderate
<i>Prunus sargentii</i>	Sargent cherry	Moderate-high	Low-moderate	Moderate-high	Moderate
<i>Prunus serotina</i>	Black cherry	Moderate	Low-moderate	High	Moderate
<i>Prunus serrulata</i>	Japanese cherry	Moderate-high	Low-moderate	Low	Low
<i>Prunus virginiana</i>	Chokecherry	Moderate-high	Low-moderate	Low	Moderate
<i>Prunus x yedoensis</i>	Yoshino cherry	High	Low-moderate	Low	Low-moderate
<i>Pyrus calleryana</i> *	Callery pear*	Low-moderate	Low-moderate	Moderate	Moderate
<i>Quercus alba</i>	White oak	Low-moderate	High	Moderate-high	Moderate
<i>Quercus bicolor</i>	Swamp white oak	Moderate	High	Moderate	Moderate
<i>Quercus coccinea</i>	Scarlet oak	Low	High	High	Moderate

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Scientific Name	Common Name	Climate Vulnerability	Health Disservices	Carbon Benefit	Health Benefit
<i>Quercus falcata</i>	Southern red oak	Low-moderate	High	Moderate	Moderate
<i>Quercus imbricaria</i>	Shingle oak	Moderate	High	Low-moderate	Moderate-high
<i>Quercus laevis</i>	Turkey oak	Low-moderate	High	Low-moderate	Moderate-high
<i>Quercus macrocarpa</i>	Bur oak	Moderate	High	Moderate-high	Moderate
<i>Quercus marilandica</i>	Blackjack oak	Moderate	High	Low	Moderate
<i>Quercus michauxii</i>	Swamp chestnut oak	Low-moderate	High	Moderate	Moderate-high
<i>Quercus muehlenbergii</i>	Chinkapin oak	Moderate-high	High	Moderate	Moderate
<i>Quercus nigra</i>	Water oak	Low-moderate	High	Moderate	Moderate
<i>Quercus pagoda</i>	Cherrybark oak	Low-moderate	High	Moderate	Moderate
<i>Quercus palustris</i>	Pin oak	Moderate-high	High	Moderate	High
<i>Quercus phellos</i>	Willow oak	Low	High	High	High
<i>Quercus prinus</i>	Chestnut oak	Moderate	High	Moderate-high	Moderate
<i>Quercus robur</i>	English oak	Moderate-high	High	Moderate	Moderate
<i>Quercus rubra</i>	Northern red oak	Moderate	High	High	Low-moderate
<i>Quercus shumardii</i>	Shumard oak	Low	High	Moderate	Moderate
<i>Quercus stellata</i>	Post oak	Moderate	High	Moderate	Moderate
<i>Quercus velutina</i>	Black oak	Low-moderate	High	High	Moderate
<i>Robinia pseudoacacia</i>	Black locust	Moderate-high	Moderate	Moderate	Low
<i>Salix babylonica v. matsudana</i>	Corkscrew willow	Low-moderate	High	Moderate	Moderate-high
<i>Salix nigra</i>	Black willow	Moderate	High	High	Moderate
<i>Sassafras albidum</i>	Sassafras	Low-moderate	Moderate	High	Moderate

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Scientific Name	Common Name	Climate Vulnerability	Health Disservices	Carbon Benefit	Health Benefit
<i>Taxodium distichum</i>	Bald cypress	Low	Low	Moderate	Moderate
<i>Thuja occidentalis</i>	Northern white cedar, Arborvitae	Moderate-high	Moderate-high	Low	Moderate
<i>Tilia americana</i>	American linden, Basswood	Moderate-high	Low-moderate	Moderate	Moderate
<i>Tilia cordata</i>	Littleleaf linden	Moderate	Low-moderate	Moderate	Low-moderate
<i>Tilia tomentosa</i>	Silver linden	Low-moderate	Low-moderate	Low-moderate	Moderate
<i>Tsuga canadensis</i>	Eastern hemlock	High	Low-moderate	Low-moderate	Moderate
<i>Ulmus alata</i>	Winged elm	Low-moderate	Moderate	High	Moderate
<i>Ulmus americana</i>	American elm	Low-moderate	Moderate	Moderate-high	Moderate
<i>Ulmus crassifolia</i>	Cedar elm	Low	Moderate	High	Low-moderate
<i>Ulmus parvifolia</i>	Chinese elm	Low	Moderate	High	Low-moderate
<i>Ulmus rubra</i>	Slippery elm	Low-moderate	Moderate	High	Low-moderate
<i>Zelkova serrata</i>	Japanese zelkova	Moderate	Moderate	Moderate	Low-moderate

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## Information Sources:

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