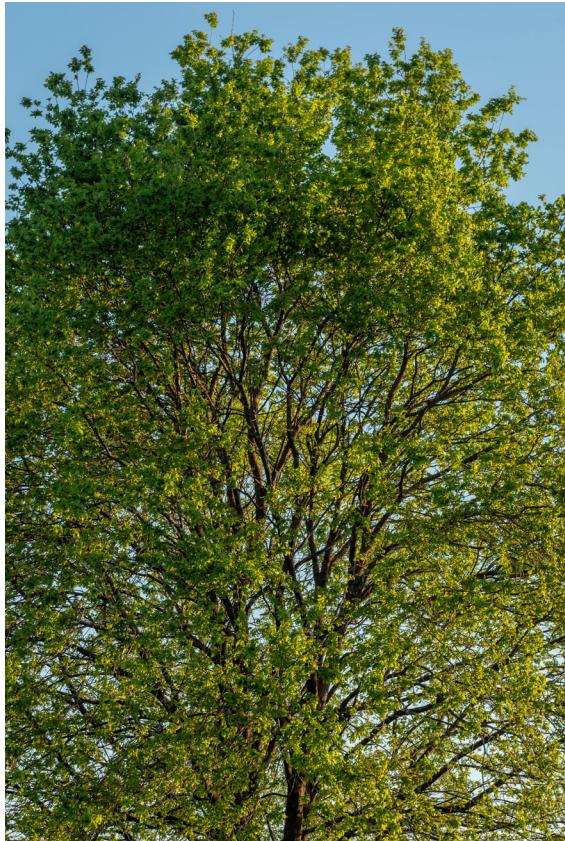


# Tree Guidelines

## Town of Littleton



**PREPARED BY**

VHB

09.18.2020



## Introduction

This document is intended to be used as a guide in the selection of trees in Littleton, MA for the public as well as for various municipal departments. It includes lists of recommended tree species within four categories;

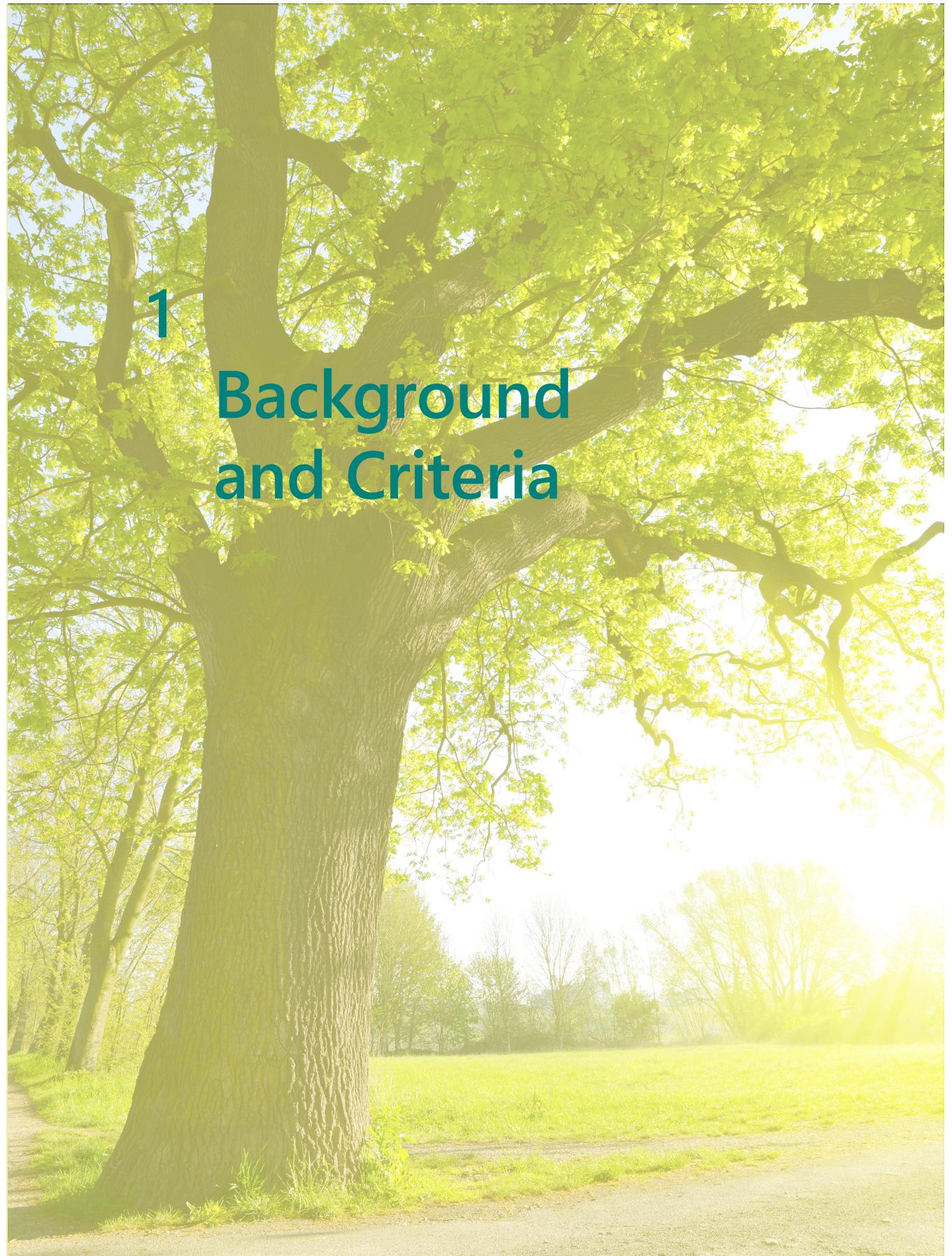
- Broad shade trees
- Upright or narrow trees
- Small trees
- Specimen trees

In addition, general information on planting locations, tree selection, and fact sheets of each recommended tree species are provided.

This guide has been prepared under a Grant made between MA Secretary of the Office for Administration and Finance and the Littleton Select Board as part of the Community Compact program. The Compact is a voluntary mutual agreement entered into between the Baker-Polito Administration and individual municipalities, where the community agrees to enter into at least one best practice that reflects the needs of the community. Thanks to the Littleton Conservation Commission, Planning Board, Shade Tree Committee, and Highway Department for their participation in this effort.

## Table of Contents

<b>1. Background and Criteria</b>	<b>4</b>
1.1 Benefits	6
1.2 Recommended Species	10
1.3 Planting Locations	18
1.4 Soils	22
<b>2. Categories and Tree Recommendations</b>	<b>24</b>
2.1 Tree Types Recommendations	26
2.2 Tree Types to Avoid	70
<b>3. Install and Maintenance</b>	<b>72</b>
3.1 Homeowner/Developer Guidelines	74
<b>4. References and Sources</b>	<b>78</b>



## 1.1

## Benefits



**Clean the Air** ..... Trees remove and sequester carbon dioxide and other pollutants



**Cool Down** ..... Trees mitigate the Heat Island Effect by shading roads and sidewalks



**Add Value** ..... Trees add beauty and increase property value



**Reduce Noise** ..... Trees and shrubs can deflect sound waves



**Create Habitats** ..... Trees can provide food, shelter, and protection for wildlife



**Improve Life** ..... The presence of trees is shown to improve focus and a sense of well-being



### Clean the Air (Carbon Sequestration)

Trees are an invaluable part of our world as they do a lot of hard work to support life on Earth. One of the biggest benefits that trees provide is the removal of carbon dioxide (as well as other pollutants) from the air, and the release of oxygen for humans and other life to use. This is important because carbon dioxide is a byproduct of daily human life, not only do we breathe it out but our cars, factories, power plants, etc. create huge amounts of CO<sub>2</sub> through the burning of fossil fuels.

Carbon dioxide released from such processes is known as a greenhouse gas, and excessive greenhouse gas is raising the earth's average temperature and causing multiple problems for humans, plants, and wildlife. Due to such large amounts of human development there is an excess of carbon dioxide on Earth, which is why planting trees is so important. Trees remove carbon dioxide from the air through a process called photosynthesis, and then use or store the byproducts. The process of trees removing carbon dioxide from the atmosphere is called carbon sequestration and it is cleaning our air and reducing our green house gases.



### Cool Down

In addition to removing carbon dioxide from the air, trees provide shade and protect us from the sun, a treat for anyone walking or playing outside on a hot summer day. Shade from trees can also mitigate the impacts of Heat Island Effect (HIE). Heat Island Effect is an increase in an area's ambient air temperature caused by surrounding buildings and pavement absorbing heat from the sun's rays and slowly releasing the heat back out. Since cities are dense with buildings and roads, cities often create "islands" of air that is hotter than the surroundings. These heat islands often cause people to turn up their air conditioning units, increasing energy usage and thereby creating more greenhouse gases resulting in poor air quality. Further compounding this problem is that people in places that do not have access to cool areas have increased risk of heat exhaustion, heat stroke, and respiratory issues.

In addition, these heat islands increase the temperature of water from rain as it moves over hot pavement. As this stormwater runoff heats up and moves into streams and lakes, those bodies of water also become warmer, disrupting the typical temperature wildlife is accustomed to and causing them health issues. This means the more trees we can plant, the more canopy we can provide to shade heat absorbing surfaces and prevent them from radiating heat back out and causing multiple issues for people and wildlife.



### Add Value

Trees add value in many ways, some more easily to quantify than others. Homeowners will find extreme value in the trees in their yard as they enhance the beauty of their property, provide shade on a hot summer day, offer children a place to play, and clean the air around a home. A well situated tree will also shade a home in the summer saving on cooling costs, and when the leaves are down in the winter the home will benefit from the sun's warmth.

Builders and developers should recognize that homeowners are looking for these benefits, and should do their best to preserve and protect existing trees when feasible on a site prior to construction and consult with a horticulturalist or arborist when possible. Trees can increase property value by approximately 10%.<sup>3</sup>



### Reduce Noise

Trees are a great option for those looking to reduce noise. Planting groups of trees and shrubs will help deflect sound waves, with larger tree leaves deflecting better than small leaves. Certain types of evergreen trees are better at reducing noise pollution than deciduous trees as the deciduous trees will drop their leaves in winter. Combining overstory trees with shrubs will create a better noise barrier as the shrubs will deflect ground level sounds. Additionally the sound of leaves rustling in the wind can mask low levels of undesirable noise.



### Create Habitats

Wildlife benefit greatly from the planting of trees as they gain habitat and resources from trees. Trees offer food, a place to live, protection from rain/heat, and a place to live or hunt to mammals, birds, reptiles, amphibian, insects, and fish. Mixing types of trees (evergreen with deciduous, shrubs with canopy trees, etc.) helps to provide a more diverse habitat than a monoculture of similar trees.

Trees even provide tremendous value to wildlife at the end of their lives in the form of food and habitat. For this reason, it is recommended to leave some dead or fallen trees (or parts of trees) on a site to provide habitat for wildlife.

Section 1.2 provides even more information on the importance of native trees and considerations for support of pollinator systems.



### Improve Life (Mental Health)

People also greatly benefit from having trees around. Not only do they provide shade, clean air and water, and a beautiful view, it has been proven that being around trees increases mental well-being.<sup>2</sup>

Being around trees makes people feel more relaxed and gives us a greater sense of well-being. Hospital rooms are now being oriented with views of trees as studies have suggested that it aids in patient recovery. Research has shown that people with Attention Deficit Disorder (ADD) are able to concentrate better after spending time outdoors. It is also believed that kindness increases after spending time around trees as well. Some studies have gone so far to connect tree canopy size directly to these positive effects, as opposed to open grassy areas that lack trees.

## 1.2

### Recommended Species

The tree species included in this guide are comprised of native species and cultivars of native species. These selected trees typically exhibit some tolerance to pollution, drought conditions, compacted soils and are generally easy to maintain.

The recommended tree lists include the Botanical (or Latin) name of the plant in italics and names of any recommended cultivars. Lists also include the common name of the plant, and abbreviated notes on the species. As many distinct plants may share the same common name, the botanical name is used to uniquely identify plant species. For some species named varieties or cultivars are recommended in preference to the regular species. A cultivar is a cultivated variety of a plant that has been selected and given a unique name because of desired characteristics. Some desirable characteristics in trees might be showier flowers, narrow shape, or increased disease resistance. These cultivated characteristics are usually quite distinct from similar plants of the same species.

In the recommended tree lists' notes, trees native to North America are indicated with the letter 'N'. Native trees are often preferred because they are typically better adapted and hardier to the climate where they are from.

Another indicator of plant hardiness to a region is the species' USDA plant hardiness zone range. The plant hardiness zone indicates the average annual minimum temperature range at which a particular species will survive. Littleton traditionally lies between zones 4 and 5, so all recommended trees are hardy to zone 5. However some homes may have microclimates of warmer or colder areas that could allow for or preclude certain species, so it is important to pay attention to the conditions of the area you hope to plant. See the individual species fact sheets for the details of each species.

### Choosing Natives

Choosing a native tree helps to eliminate a lot of guesswork when first trying to decide on a tree. Native trees are already suited to living under the growing conditions of the area they are from. They have adapted to the native soil types, rainfall amounts, high/low temperatures, animal pressure, and pollinator availability.

Native plants supply a greater variety, quality and quantity of food and shelter to native wildlife. For example, one pair of chickadees require up to 9,000 caterpillars to get their chicks to fledging. Native oaks can support almost 600 different species of caterpillars, while the non-native Ginkgo tree may support only four. Native cherry trees can support almost 500 species of caterpillars, while non-native Zelkova has been shown to support none. At least 13 mammals and 32 species of birds rely on native oaks for food, and 473 moths and butterflies use them as host plants for their caterpillars.<sup>5</sup> This highlights the benefit of planting native trees whenever possible. Sites such as the National Wildlife Federation (<https://nwf.org/NativePlantFinder/>) can help you find native plants for your area by entering in your zip code.

### Cultivars

Consider if the specimen you are buying is a cultivar or not. Cultivars don't have as much genetic diversity as "straight" native species have as they are often clones of one plant. If a cultivar has changed leaf variegation or color to red, purple, or blue, it has been found that the plants are less attractive to insects that would otherwise depend on the leaves as a food source. Even changing flower traits such as size, color, or shape also changes the availability and/or the quality of pollen and nectar offered by to wildlife. Cultivars that change characteristics such as growth form for a narrower or shorter form may still provide the original benefits of the tree for the food web. And certainly cultivars that have been developed to be disease resistant, such as against the Dutch Elm Disease, are valuable.

### Avoiding Non-Natives/Invasives

Invasive plants are plants alien to an area that thrive so well in a new environment that the native plants are unable to compete and are eventually pushed out. When the native plants are pushed out of an area by alien invasives, the native wildlife are also adversely affected by this change. Animals and insects that used to depend on the native plants often cannot use or eat the alien plants the way they could the natives, causing disruption to the entire food web. Some of the most common invasive trees in Littleton are *Acer platanoides* / Norway Maple, *Ailanthus altissima* / Tree of Heaven, and *Robinia pseudoacacia* / Black Locust. Many states have lists of invasive plants that are not allowed to be sold or brought into the state.

Massachusetts's list of invasive plants can be found here: <https://www.mass.gov/doc/invasive-plant-list/download>, and a list of prohibited plants here: <https://www.mass.gov/massachusetts-prohibited-plant-list>. These references should be reviewed prior to selecting any plant material for your home or project.

It is important to note that non-native plants are not necessarily invasive plants. These alien plants only become invasive when they are overly aggressive and dominate an area and out-compete native plants. Alien trees can often be great options under certain conditions. Street trees are an example, as these trees need to survive dry, polluted, sometimes salty, and often hot conditions. For these reasons trees that do well near the ocean, or are from warmer climates, are excellent options. Some garden enthusiasts collect alien ornamentals from different areas of the world to enjoy unique flowers, fruit, or foliage. However if we are hoping to support local wildlife and restore local ecosystems that are in great danger, then native trees are the best choice.

## Climate Change & Zone Creep

Climate change is the weather on earth changing over the long-term from what is typical at a rate that is not typical, whether it is a change in temperature or in precipitation amounts. The Earth is currently becoming warmer on average due to the build up of greenhouse gases coming from human activity trapping heat close to the Earth's surface. This warming is setting off a series of further harmful events, such as ice melting causing sea levels to rise and typical plant growth and flowering timing changes. Spring temperatures are starting to come earlier encouraging plants to begin leafing out, but we are still experiencing late freezes so new plant growth/flowers are at risk of damage from freezing..

Climate change is having a direct impact on plant material. As temperatures warm, a town that has been classified as USDA plant hardiness zone 7 based on average annual minimum winter temperatures, may in time warm to a zone 8. This zone creep is a phenomenon that humans can react quickly to by moving to cooler areas, but trees cannot up and leave. For the homeowner looking to choose a new tree, this means that being diligent in reading plant tags or doing research beforehand about the range of trees and potentially avoiding trees that are marginally hardy becomes more important. To be extremely forward thinking, we may look to planting trees that are very common in the Mid-Atlantic states, whose ranges are slowly creeping northward. When in doubt about a tree, consult your local nursery professional to verify its viability in this area.

## Pollinators

Trees play an important role in the lives of pollinators. Pollinators are animals (typically insects, birds, or bats) that move pollen from stamen (male part) to a stigma (female part) of a plant, allowing for the creation of fruit and seeds. While some plants are able to self-pollinate, or utilize wind and water, pollinators are essential to a healthy ecosystem. Pollinators and plants (including trees) form a symbiotic relationship, with the plant providing food and the pollinator ensuring the continuation of the life cycle of the plants and assisting in the creation of the fruits, vegetables, and grains we eat to survive. Even trees without obvious "flowers" such as Oaks and Maples require pollination to produce their acorns and samara (known locally as whirligigs). Some excellent options for support of pollinator systems include:

- *Acer spp.* / Maple
- *Betula spp.* / Birch
- *Cladrastis kentukea* / Yellowwood
- *Cornus alternifolia* / Alternate Leaf Dogwood
- *Ilex opaca* / American Holly
- *Malus spp.* / Crabapple
- *Amelanchier laevis* / Serviceberry
- *Liriodendron tulipifera* / Tulip Tree
- *Oxydendrum arboreum* / Sourwood
- *Nyssa sylvatica* / Tupelo
- *Populus spp.* / Aspen/Poplar/Cottonwood
- *Prunus spp.* / Cherry/Plum
- *Salix spp.* / Willow
- *Quercus spp.* / Oak
- *Tilia Americana* / American Linden

## Pests

With the creation of a more vibrant global culture so too has come a few nuisances. An increase in importing and exporting has caused the accidental arrival of insects from other countries that are harmful to native and non-native trees. While insects do spread by their own means, humans often inadvertently help them. One way people can slow the spread is by not moving dead trees or firewood outside of the site they came from. Campsites often have firewood available for sale within the grounds that is from local and reliable sources.

Below are a few lists of insects that are currently or potentially will be problematic.

### Asian Long Horned Beetle

Listed below for reference is a list of known hosts of the Asian Long-horned Beetle. At the time this tree guide was prepared, Asian Long-horned Beetle infestation had not extended into Littleton but remains a concern in the region. This list is provided for informational purposes.

#### **Significant host of ALB (as of this writing):**

- Maple (*Acer* species)
- Horsechestnut (*Aesculus* species)
- Willow (*Salix* species)
- Elm (*Ulmus* species)
- Birch (*Betula* species)
- Mimosa (*Albizia julibrissum*)
- Hackberry (*Celtis* species)
- Ash (*Fraxinus* species)
- Sycamore and Plane tree (*Platanus* species)
- Mountain Ash (*Sorbus* species)
- Poplar (*Populus* species)

To report signs of ALB visit: <https://massnrc.org/pests/albreport.aspx>

### Emerald Ash Borer Beetle

Listed below for reference is a list of known hosts of the Emerald Ash Borer (EAB). At the time this tree guide was prepared, EAB infestation is present in Littleton and spread to neighboring areas remains a concern. This list is provided for informational purposes.

#### **Significant host of EAB (as of this writing):**

Ash (*Fraxinus* species)

To report signs of EAB visit: <https://massnrc.org/pests/eabreport.htm>

### Spotted Lantern Fly

Listed below for reference is a list of known hosts of the Spotted Lanternfly. At the time this tree guide was prepared, two dead Spotted Lanternflies have been found in Metrowest Massachusetts on material brought in from Pennsylvania. This list is provided for informational purposes.

#### **Main host of Spotted Lanternfly (as of this writing)**

Tree of Heaven (*Ailanthus altissima*) (invasive)

#### **Additional hosts of Spotted Lanternfly**

- Grape (*Vitis* spp.)
- Apple (*Malus* spp.)
- Maple (*Acer* spp.)
- Birch (*Betula* spp.)
- Willow (*Salix* spp.)
- Plum (*Prunus* spp.)
- Pine (*Pinus* spp.)
- And 100+ more

To report signs of Spotted Lanternfly visit: <https://massnrc.org/pests/slreport.aspx>

## Diversity (Avoiding Monocultures)

It is important to have a diverse variety of trees in an area. If a single type of tree dominates an area and a pest or disease is introduced that kills or weakens that tree, then the area could be left treeless. Often this is not a problem on small residential properties, but it is worth recognizing as homeowners can choose to select a tree that would increase the diversity of the tree canopy within their neighborhood and thereby add to the biodiversity of their town.

A cautionary tale is that of *Ulmus americana* / American Elm. A tall tree with a graceful branching pattern and a wide canopy, the American Elm was extremely popular in the 19th and early 20th century as a street and lawn tree. However, Dutch Elm Disease (DED), a fungal disease that spread via elm bark beetles and touching roots, appeared in the US in the 1920s and began killing America's Elms. The disease spread quickly through the Elm population because many streets and parks across the country were planted with dense monocultures of Elms. These planted trees also had low genetic diversity as they were grown in nurseries rather than genetically diverse populations in the wild, so the chances of a more resistant tree amongst the monoculture were very low. Anywhere from 55 to 75 million Elm trees died by 1989, many of them over 50 years old. While the disease is still active, a few DED-resistant varieties have been cultivated and are in use today. This is a why planting a diversity of trees is a good idea, especially along streets and in parks.

## Market Availability

Although there are many trees in the world, what we are able to bring into our yards is limited by what we can find in a nursery. Most local nurseries carry trees and plants that will do well in the surrounding area and the staff are very knowledgeable. Local nurseries are equipped to take great care of the plants, have great variety of plants, and can sometimes order in specific plants if they're not currently available. Plants are also often available for purchase at big box stores, but staff tend to not be trained as much as a local nursery, the quality and variety of plants will be less, and the appropriateness of the selections are sometimes questionable. For unique and native plants try looking at a local nursery first.

## Additional Tree Considerations

These guidelines focus on trees that are native, hardy, and attractive with minimum maintenance. There are far more native trees available for purchase that provide many benefits for the environment, but may require additional maintenance, research before planting, more work to locate, and may be sold in smaller sizes. Some of these hard working natives include:

- *Prunus spp.* / Cherry
- *Salix spp.* / Willow
- *Populus spp.* / Cottonwood
- *Carya spp.* / Hickory

It is important to research these specific trees before planting and/or consult your local nursery professional to confirm "right tree, right place".

## 1.3

### Planting Locations

Before choosing a tree, it is helpful to investigate the area for the tree ahead of time. Determine how much room on the ground, in the air, and under the ground is available for the tree and its canopy and roots. Whenever possible, a good rule of thumb is to provide a 30'x30' ground space area for large trees, 15'x15' for upright trees, and 7'x7' for small ornamental trees. Specimen trees should also provide for a 30'x30' ground space area. These guidelines do not exempt applicants from obtaining all required permits and complying with applicable bylaws and regulations.

#### Street Trees

It is often not possible to provide an ideal growth area for street trees. If planting in a lawn strip along a roadway, the ideal width for this lawn strip is 8' for large trees, 6' for upright or narrow trees, and 4' for small trees. When planting in tree pits within sidewalks, provide planting areas that are 4'x6' and as deep as each tree's rootball. Also consider providing perforated aeration/watering tubes in the pits.

#### Planting Location

Some possible physical conflicts to consider when locating tree plantings are buildings, signage, sidewalks and pedestrians, cars, snow storage, overhead wires, and underground utilities.

#### 1. Overhead Wires and Underground Utilities

- a. Always call Dig Safe to locate utility in the area being considered for tree planting before digging. (Dial 811 in Massachusetts, Maine, New Hampshire, Rhode Island, and Vermont. This service is free of charge.)
- b. If there is less than 8'-10' horizontal clearance to a utility or building obstruction above or below grade, consider another location for the tree.
- c. Avoid planting trees under or near overhead wires (OHW). If this cannot be accommodated and there is less than 8' horizontal clearance from the wires use small ornamental trees under or near the wires. If the location is constrained by OHW's but will allow for at least 8'-15' horizontal clearance then narrow trees may also be considered.
- d. Avoid planting trees over underground utility lines and structures, especially if it is likely the lines will need repair or construction work. Most trees are sensitive to root damage or disturbance and repair work might even necessitate removal of trees. If trees must be planted over utilities keep in mind that the trees will need a minimum 3' planting depth over the utility. Some utilities such as gas lines may leak and kill tree plantings. Other utilities such as steam lines may emit heat which will also kill tree plantings. Conversely older segmented utility lines such as sewers may be prone to intrusion and damage from roots of trees planted too closely.
- e. Provide 15' horizontal clearance from street lights.

#### 2. Sidewalks

- a. Where sidewalks exist, in order to provide an improved growing condition a priority should be placed upon locating trees in green spaces at the back of sidewalk (far side from the roadway) or in front yards rather than in tree pits or narrow lawn strips at the edge of roadways. These areas at the back of sidewalk provide more room for root growth, greater protection from root compaction and snow storage and less exposure to road salt.
- b. Sidewalks must maintain a 5' minimum clear path to provide room for sidewalk plows and sweeping tools. To provide a minimum 4' wide tree pit in a sidewalk and a 5' passage requires a minimum 9' sidewalk, not including any curb width.
- c. In cases where trees are required to be planted either in green strips between sidewalk and road edge or in tree pits within sidewalks, they should be located so that the center of trunk is no less than 2' from walk or curb. 4' or more from walk or curb is preferred.
- d. Trees should be located to avoid possible injury to pedestrians from lower branches should provide a 6'-8" branching height when directly adjacent to sidewalks. New Broad Shade and Upright Street trees in the 3" caliper range can usually be purchased with a 6'-8" branching height. Ornamental trees or trees with small size at installation and hence with smaller lower branching canopies should be located further away from walks.
- e. Think carefully about the use of trees with fleshy fruit or other fruit litter in areas with a lot of pedestrian activity like public plazas or play areas.

### 3. Buildings in Urban Conditions where the sidewalk meets the building face

- a. Use upright, narrow, trees where they must be planted close to buildings. This will help to minimize conflicts with branches.
- b. Do not plant trees in front of building entries.
- c. If possible, use trees to frame storefront signage or display windows. Avoid planting directly in front of signage and try to maintain some visibility for merchants.

### 4. Vehicular Issues

- a. When locating trees near street intersections consider the mature size of the tree and how they may impact sight lines of vehicles turning corners.
- b. A minimum 4' wide planting strip or tree pit can accommodate vehicular door swing where street trees are planted next to on-street parking.
- c. Most vehicles have a bumper overhang past the edge of parking areas of 2-3.5'. Where trees will be planted near head-in parking, provide at least 4' clearance from the edge of pavement or face of curb to the tree. This will prevent trees from being struck or damaged by vehicles.
- d. Consider snow-plow operations and snow storage locations when locating trees. Where snow plows might be expected to push toward the tree planting area, a minimum clearance of 10' from the edge of pavement is required to minimize damage to tree trunks.
- e. We recommend a 18' branch height minimum for roadside trees to eliminate conflict with vehicles on the roadway. Trees on main roads should be cut even higher.

## 1.4

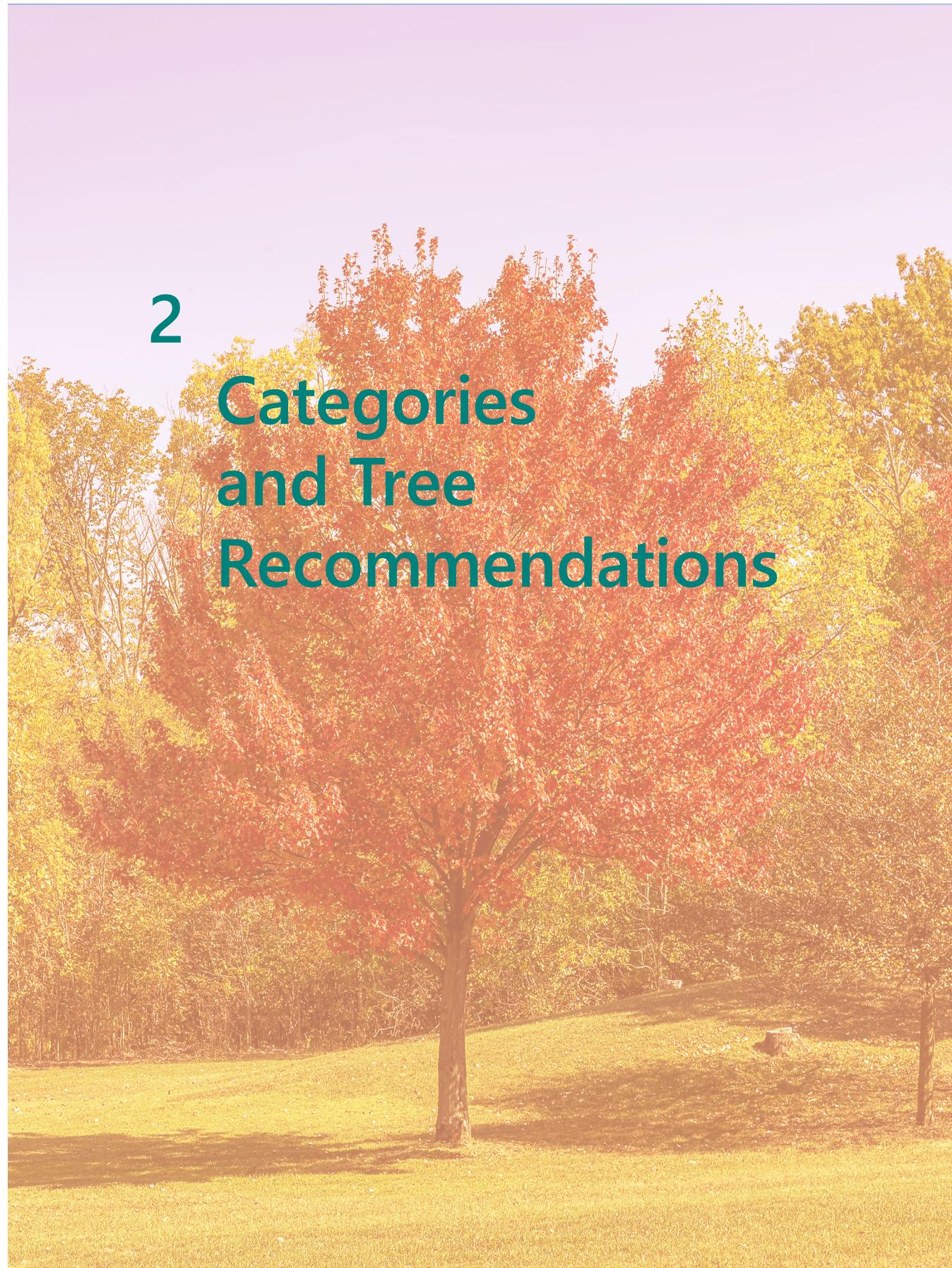
### Soils

#### Testing and Amending

Before investing in a new tree you may want to do a soil test to determine the amount of nutrients present in your yard in order to find out what you can do to improve the soil's condition. For quick approximate results local garden and hardware stores have soil kits that will give you pH and basic nutrient levels. However, for a comprehensive analysis including suggestions for amendments, sending a soil sample to a local university's cooperative extension is recommended. In Massachusetts the University of Massachusetts Amherst offers multiple testing options. A good starting place is: <https://ag.umass.edu/services/soil-plant-nutrient-testing-laboratory>.

#### Structural Soil vs. Standard Tree Pit Options for Street Trees

The viability of a street tree is dependent on multiple factors. Selecting a tree appropriate for a certain environment and providing appropriate watering and nutrients as the tree becomes established aids in its success. The success of a tree is easily evaluated above ground, but the viability of the tree is equally tied to its root system below ground. Providing an adequate area for the roots to spread as the tree grows is equally important to above ground maintenance. At a minimum, providing a tree pit that is three times the root ball at installation and backfilling with a planting soil allows for proper root aeration and growth. In urban contexts, trees are often planted in tree pits or tree grates that are bounded on either side by sidewalks and roadways. Healthy root zones are impeded by soil compaction that is needed to provide structural stability for the sidewalk or roadway so it does not crack or warp. New advances in soil research have created options for sand-based structural soils that provide the needed stability for pavements, but also allow for the root systems of trees to spread. Littleton should consider using sand-based structural soils where new trees are being installed along roadways with sidewalks, and creating a sand-based structural soil specification for developers to reference when planting in these situations.

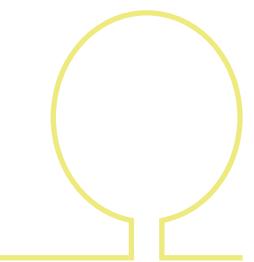


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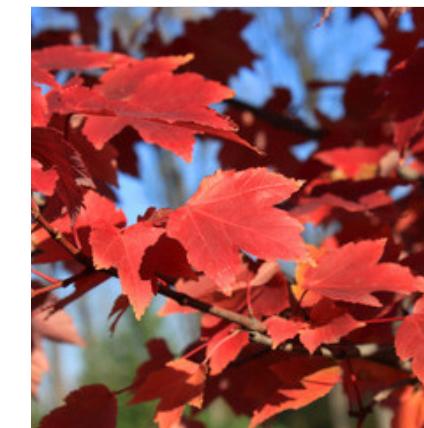
## Tree Types Recommendations

## Broad Shade Trees

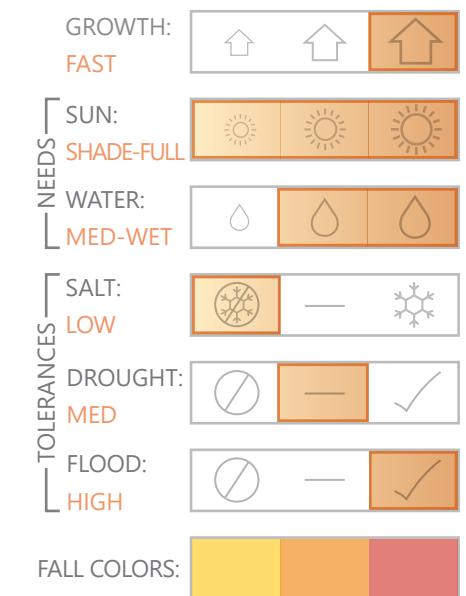
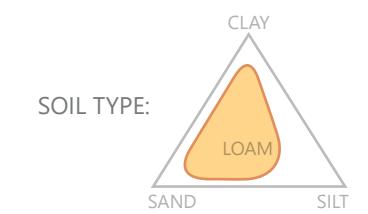
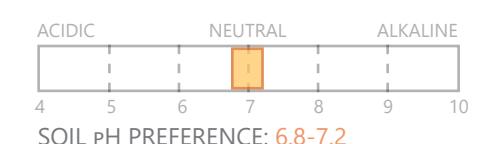
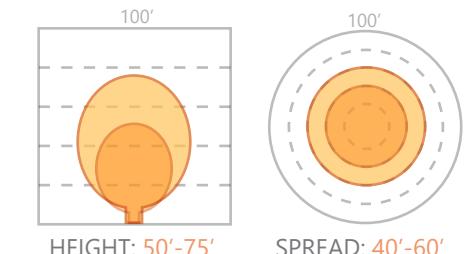
The following trees are recommended for unconfined spaces such as lawns, parks, yards, and wide landscape buffers. Ideal growth area is 30'x30'x3'D. They can also be used as street trees provided they are planted in an adequate space on the outside of sidewalks. More specific information for each tree can be found on the following pages.



Botanical Name	Common Name	Uses
		STREET TREE
		UNDER POWER LINES
<i>Acer rubrum</i>	Red Maple	
<i>Liquidambar styraciflua</i>	Sweetgum	
<i>Nyssa sylvatica</i>	Black Tupelo	
<i>Ostrya virginiana</i>	American Hophornbeam	
<i>Quercus alba</i>	White Oak	
<i>Quercus bicolor</i>	Swamp White Oak	
<i>Quercus coccinea</i>	Scarlet Oak	
<i>Quercus palustris</i>	Pin Oak	
<i>Quercus rubra</i>	Red Oak	
<i>Ulmus americana 'Valley Forge'</i>	American Elm	



FRUIT: RED, DRY, ELONGATED  
USDA PLANTING RANGE: 4a-10b  
FORM: OVAL/ROUNDED

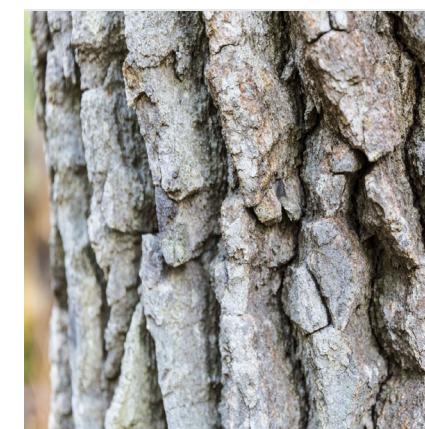
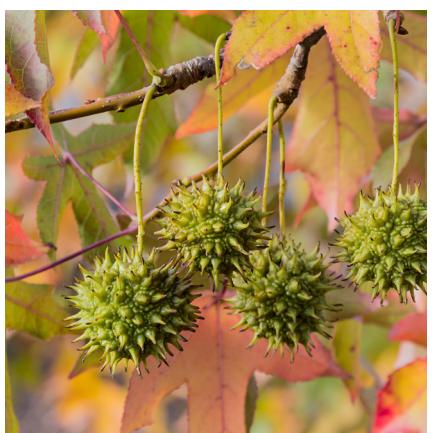
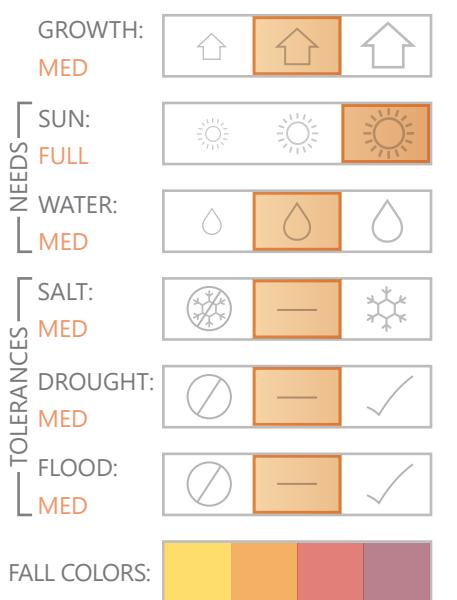
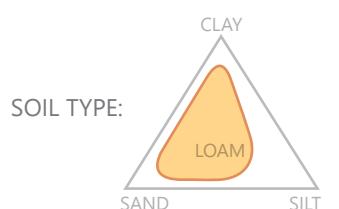
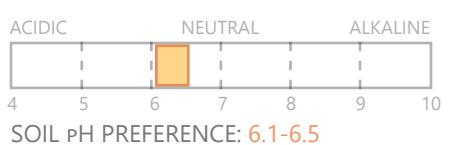
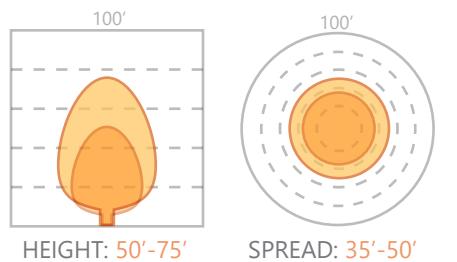




## *Liquidambar styraciflua*

**Sweetgum, Red Gum**  
*Hamamelidaceae*  
 (Witch Hazel Family)

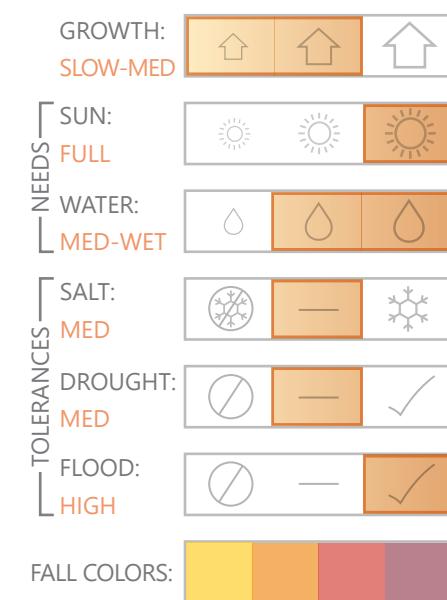
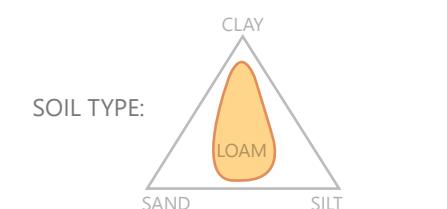
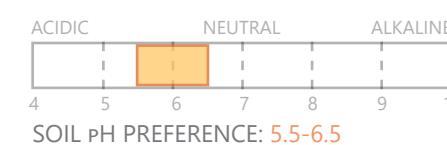
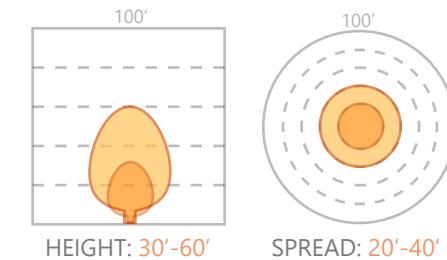
FRUIT: BROWN, DRY, ROUND  
 USDA PLANTING RANGE: 5-9  
 FORM: OVAL TO PYRAMIDAL



## *Nyssa sylvatica*

**Black Tupelo, Black Gum**  
*Nyssaceae*  
 (Dogwood Family)

FRUIT: BLUE, BLACK DRUPES  
 USDA PLANTING RANGE: 3-9  
 FORM: PYR. (YOUNG) OVAL (MATURE)

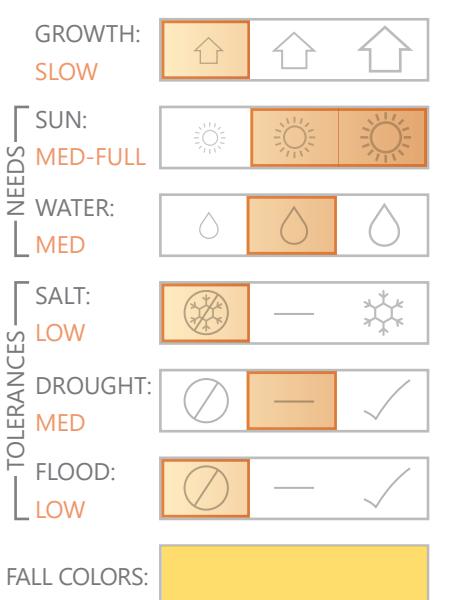
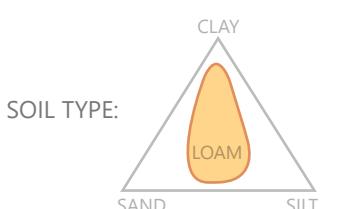
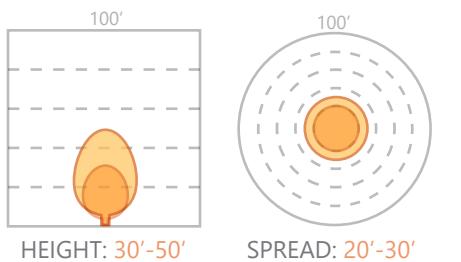




## *Ostrya virginiana*

**American Hophornbeams**  
*Betulaceae* (Birch Family)

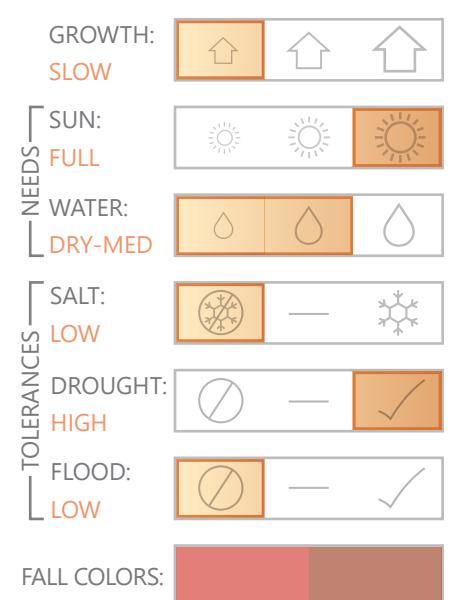
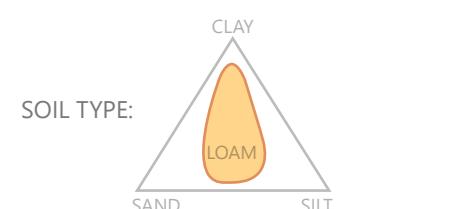
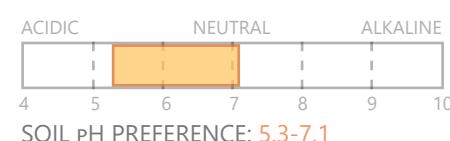
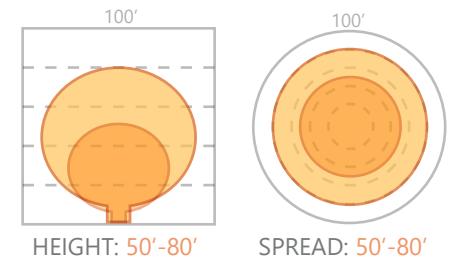
FRUIT: GREEN/WHITE PODS CLUSTERS  
USDA PLANTING RANGE: 3-9  
FORM: PYR. (YOUNG) OVAL (MATURE)



## *Quercus alba*

**White Oak**  
*Fagaceae* (Beech Family)

FRUIT: BROWN, OVAL 3/4" ACORN  
USDA PLANTING RANGE: 3A-9A  
FORM: PYR. (YOUNG) ROUND (MATURE)

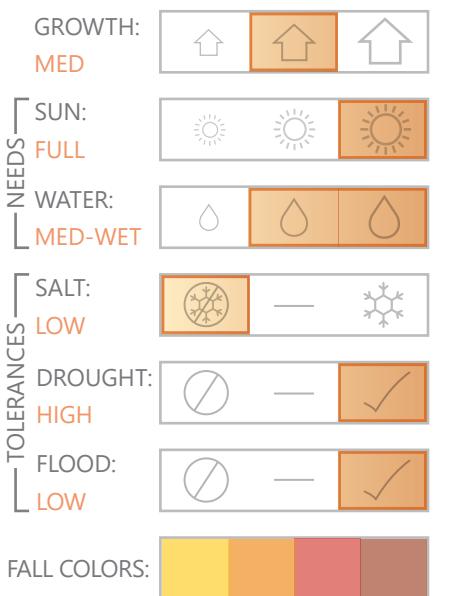
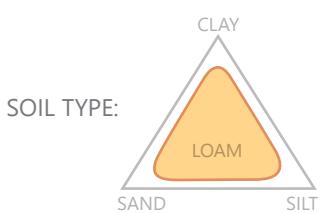
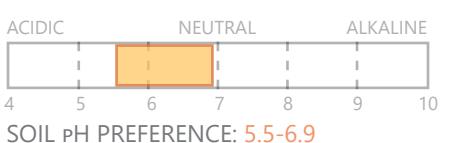
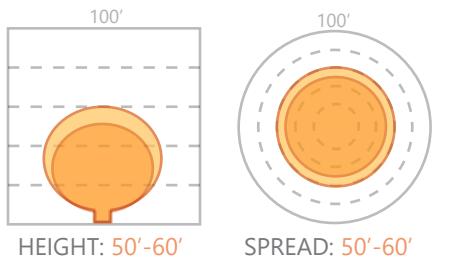




## *Quercus bicolor*

**Swamp White Oak**  
Fagaceae (Beech Family)

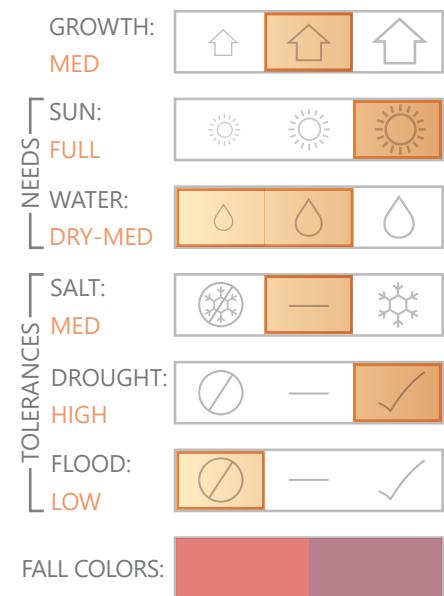
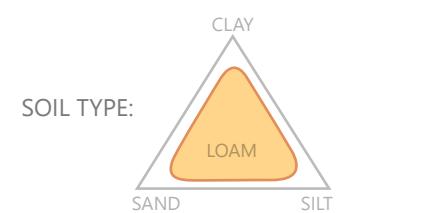
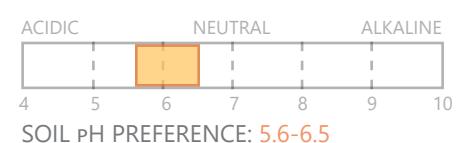
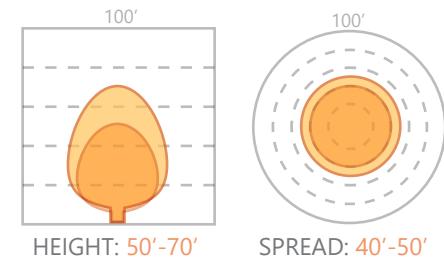
FRUIT: FRUIT: OVAL 3/4" ACORN  
USDA PLANTING RANGE: 3B-9A  
FORM: ROUNDED



## *Quercus coccinea*

**Scarlet Oak**  
Fagaceae (Beech Family)

FRUIT: BROWN, OVAL 3/4" ACORN  
USDA PLANTING RANGE: 4A-9A  
FORM: PYRAMIDAL/ROUNDED

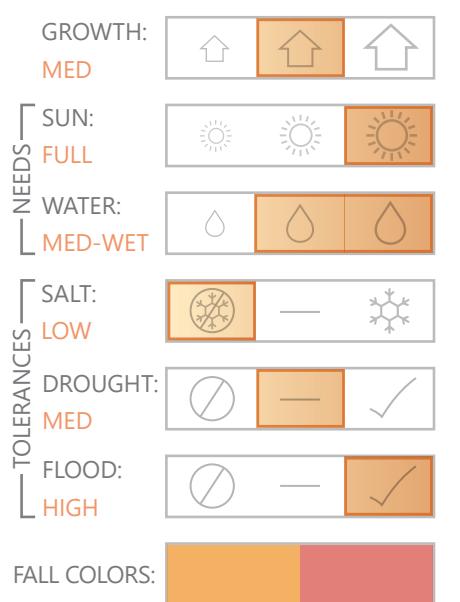
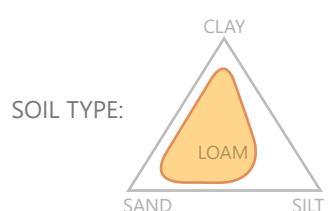
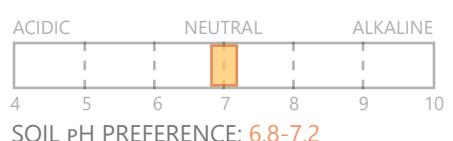
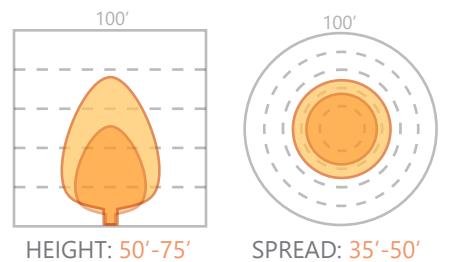




## *Quercus palustris*

**Pin Oak, Swamp Oak**  
*Fagaceae* (Beech Family)

FRUIT: BROWN, ROUND 1/2" ACORN  
USDA PLANTING RANGE: 4A-8A  
FORM: PYRAMIDAL



## *Quercus rubra*

**Red Oak, Northern Red Oak**  
*Fagaceae* (Beech Family)

FRUIT: BROWN, FLAT-TOPPED ACORN  
USDA PLANTING RANGE: 3B-8A  
FORM: ROUNDED

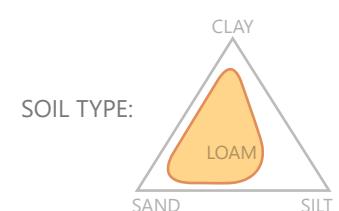
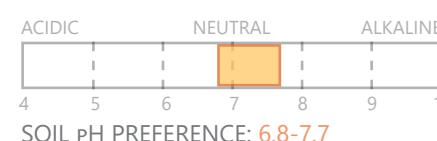
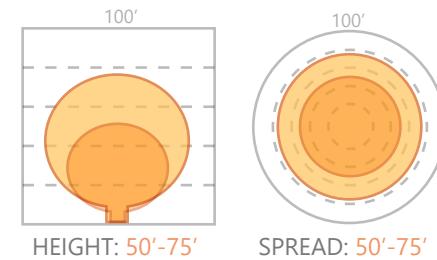
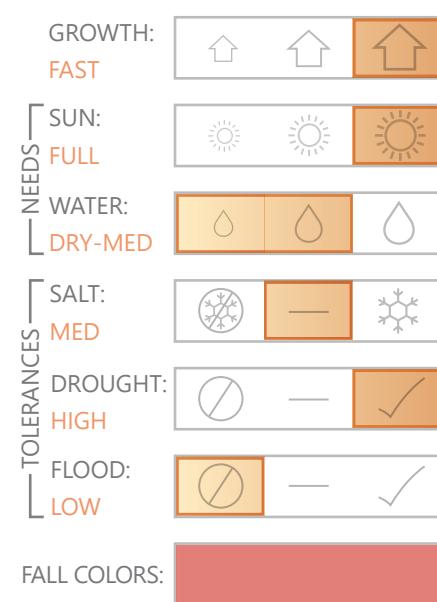
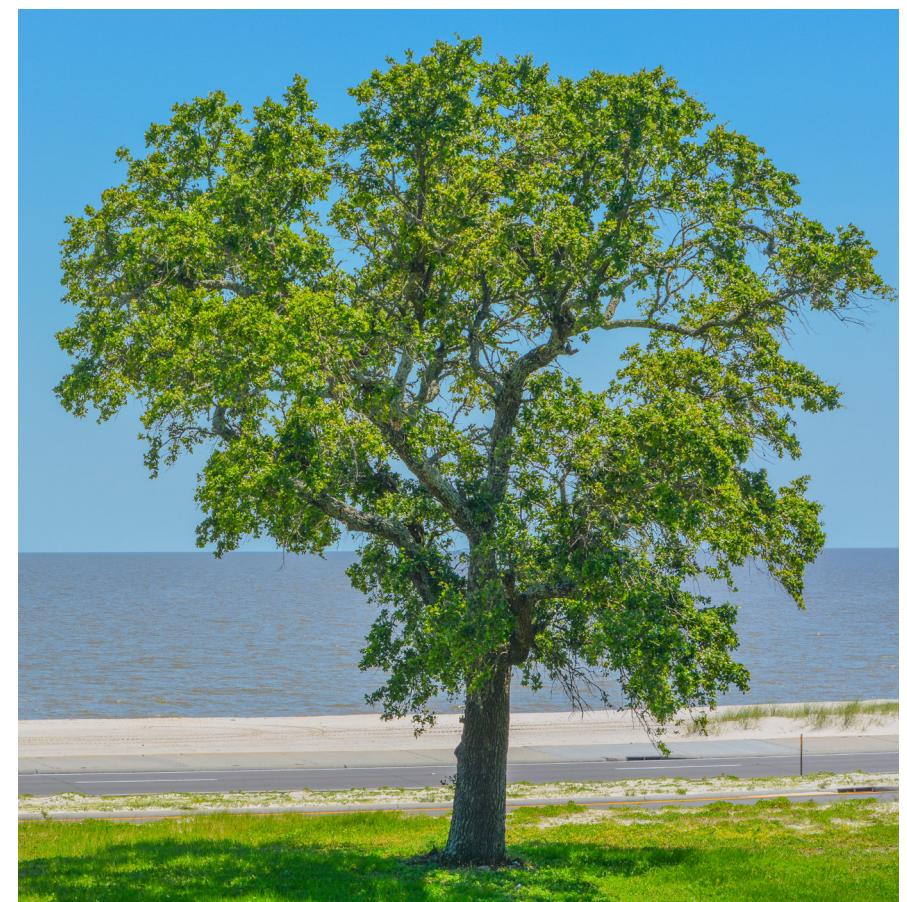


Photo: Simply Trees  
<http://www.simplytreeservice.com/>





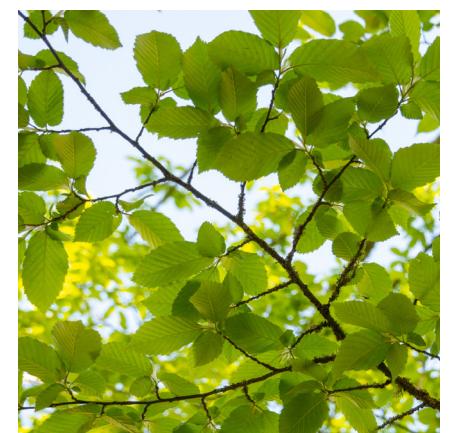
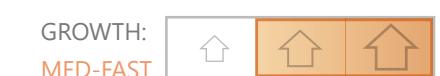
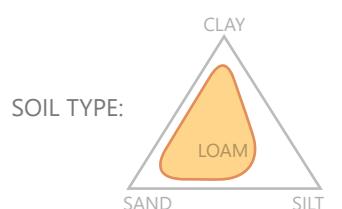
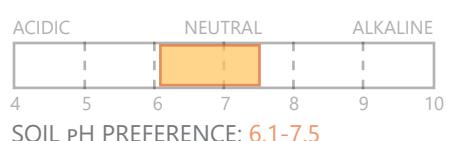
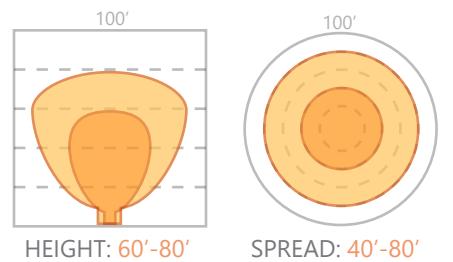
## *Ulmus americana* 'Valley Forge'

**American Elm**  
*Ulmaceae* (Elm Family)

FRUIT: BROWN, DRY, ROUND

USDA PLANTING RANGE: 3A-9B

FORM: VASE SHAPED



## Upright or Narrow Trees

The following trees are recommended for use in narrow lots where a single tree or screen is desired, or on streets where pedestrian walks and proximity to buildings pose constrained space conditions. Ideal growth area averages 15'x15'x3'D. More specific information for each tree can be found on the following pages.

Botanical Name	Common Name	Uses
		STREET TREE      UNDER POWER LINES
<i>Acer rubrum 'Bowhall'</i>	Bowhall Red Maple	
<i>Acer rubrum 'Karpick'</i>	Karpick Red Maple	●
<i>Liquidambar styraciflua 'Slender Silhouette'</i>	Sweetgum	●
<i>Quercus bicolor 'Bonnie and Mike'</i>	Bonnie and Mike Swamp White Oak	
<i>Quercus palustris 'Green Pillar'</i>	Fastigate Pin Oak	●



Photo: The Site Gardener  
<http://www.thesitegardener.com/>



Photo: The Dawes Arboretum  
<https://dawesarb.org/>



Photo: Washington State University  
<https://pnwplants.wsu.edu/>

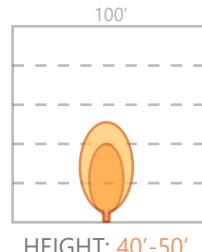
## *Acer rubrum 'Bowhall'*

**Bowhall Red Maple**  
*Aceraceae* (Maple Family)

FRUIT: DRY, RED, 1"-3"

USDA PLANTING RANGE: 4A-8B

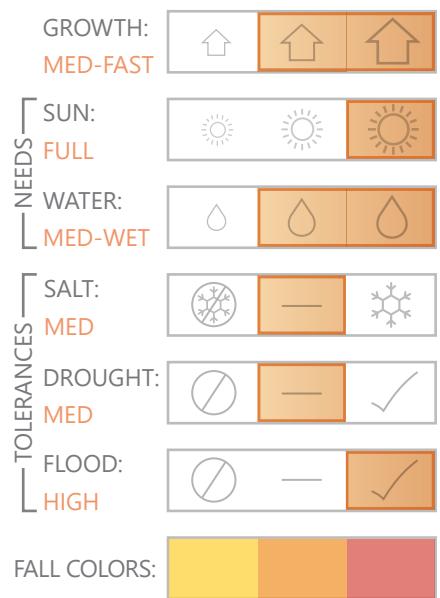
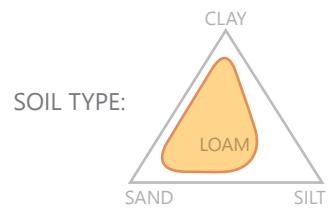
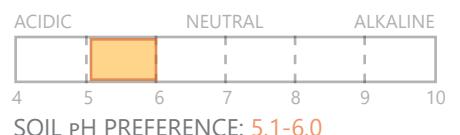
FORM: COLUMNAR/oval



HEIGHT: 40'-50'



SPREAD: 15'-25'





## *Acer rubrum* 'Karpick'

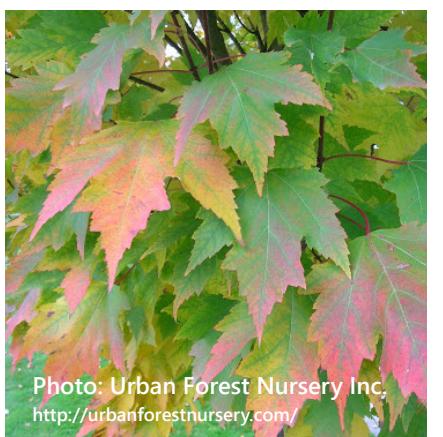
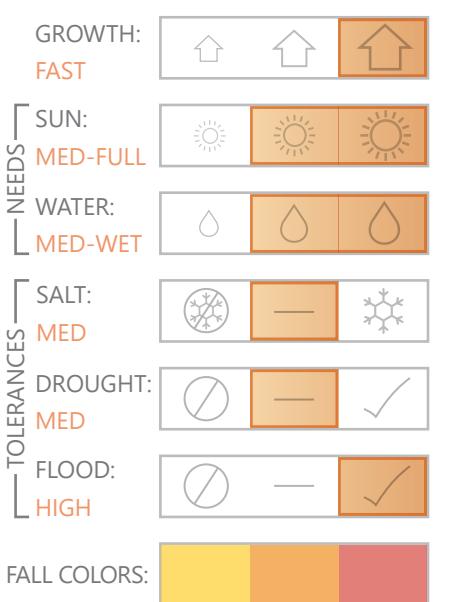
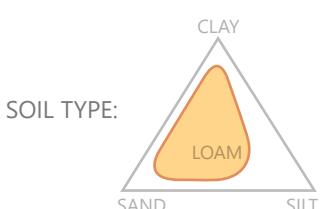
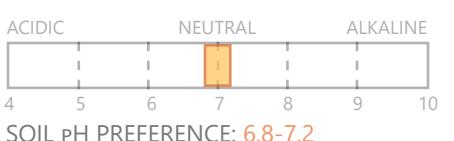
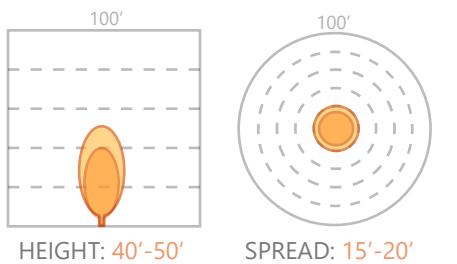
### Karpick Red Maple

Aceraceae (Maple Family)

FRUIT: NONE

USDA PLANTING RANGE: 4A-8B

FORM: COLUMNAR/oval



## *Liquidambar* *styraciflua* 'Slender Silhouette'

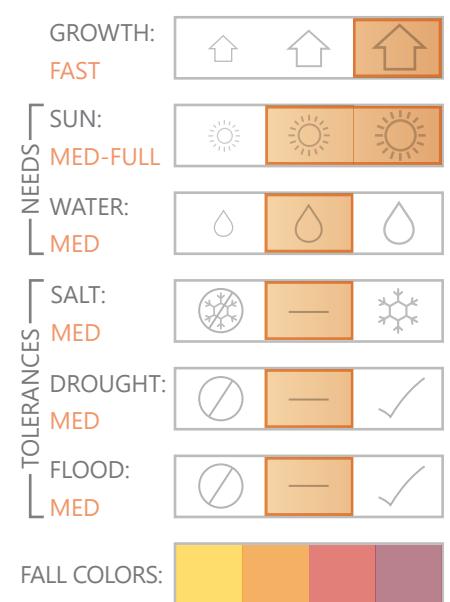
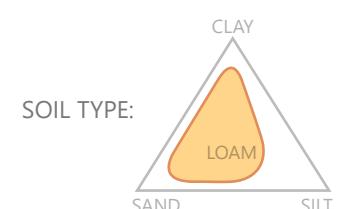
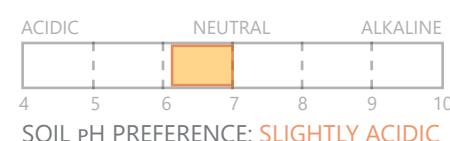
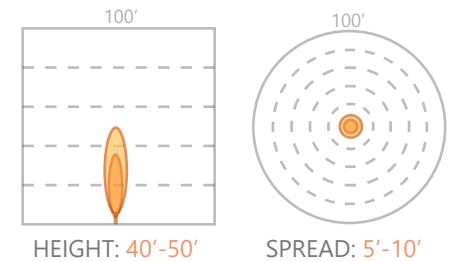
### Slender Silhouette Sweetgum

Altingiaceae (Gum Family)

FRUIT: BROWN, 1" DIAMETER

USDA PLANTING RANGE: 5-9

FORM: NARROW, COLUMNAR





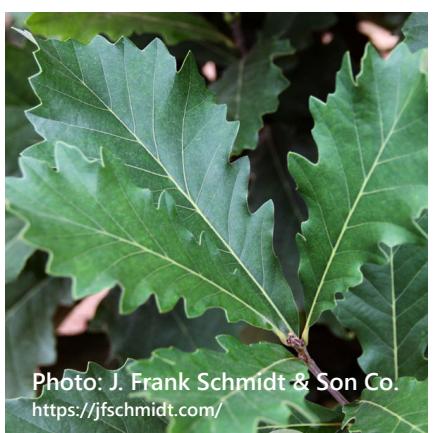
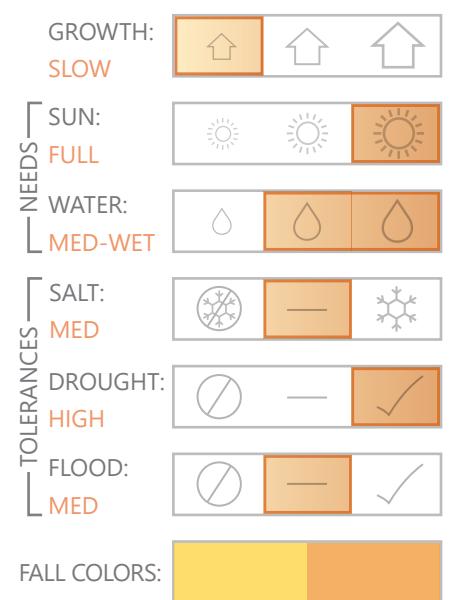
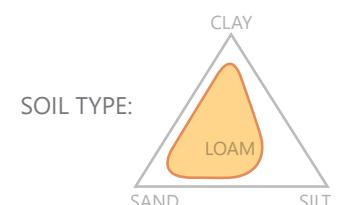
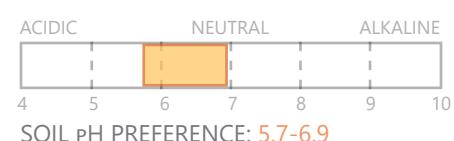
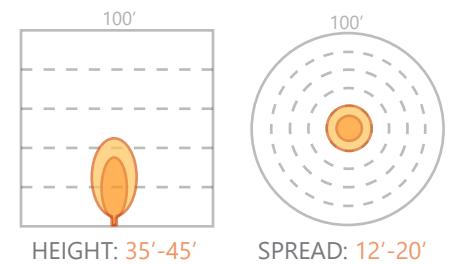
## *Quercus bicolor* 'Bonnie and Mike'

**Beacon Swamp White Oak**  
*Fagaceae* (Beech Family)

FRUIT: BROWN, DRY, OVAL/ROUND

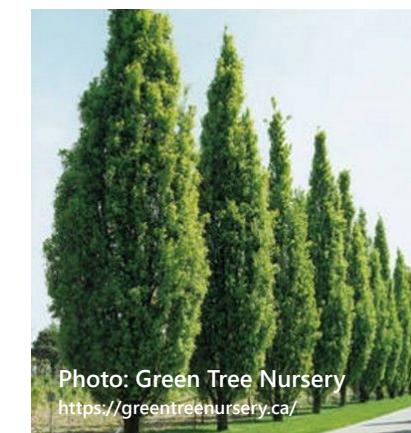
USDA PLANTING RANGE: 4-8

FORM: NARROW, COLUMNAR



## *Quercus palustris* 'Green Pillar'

**Fastigate Pin Oak**  
*Fagaceae* (Beech Family)



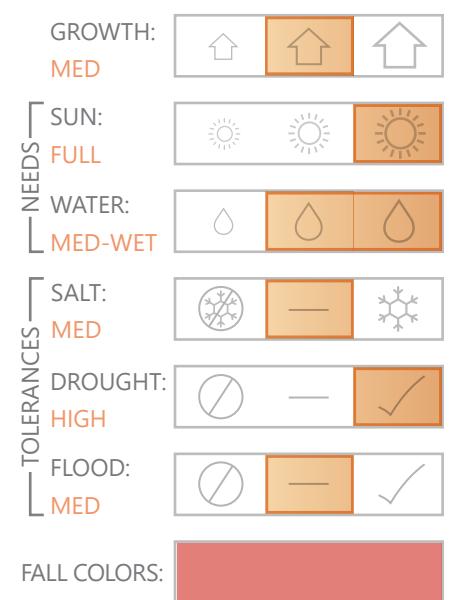
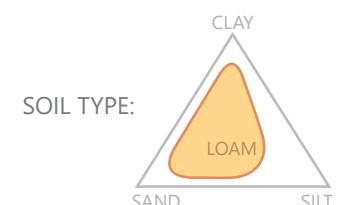
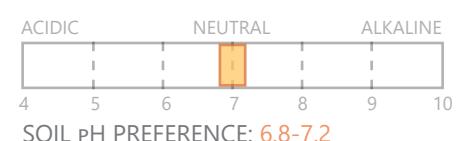
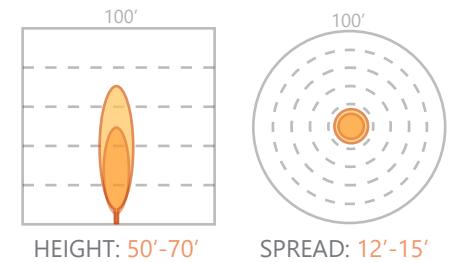
## *Quercus palustris* 'Green Pillar'

**Fastigate Pin Oak**  
*Fagaceae* (Beech Family)

FRUIT: BROWN, DRY, OVAL/ROUND

USDA PLANTING RANGE: 4-8

FORM: NARROW, COLUMNAR



## Small Trees

The following trees are recommended for use under or near overhead wires, in confined spaces, or for ornamental accent. Ideal growth area averages 7'x7'x3'D. More specific information for each tree can be found on the following pages.

Botanical Name	Common Name	Uses
		STREET TREE      UNDER POWER LINES
<i>Amelanchier x grandiflora</i> 'Robin Hill'	Robin Hill Serviceberry	●      ●
<i>Amelanchier laevis</i> 'Lustre'	Lustre Allegheny Serviceberry	●
<i>Cercis canadensis</i>	Eastern Redbud	●      ●
<i>Cornus florida</i>	Flowering Dogwood	●      ●
<i>Crataegus crus-galli</i> 'Inermis'	Thornless Cockspur Hawthorn	●      ●
<i>Halesia tetrapetra</i>	Carolina Silverbell	●
<i>Hamamelis virginiana</i>	Witch Hazel	●
<i>Prunus virginiana</i> 'Schubert'	Canada Red Chokeberry	●



Photo: Green Mile Trees  
<https://www.greenmiletrees.co.uk/>



Photo: The Telegraph  
<https://www.telegraph.co.uk/>



Photo: Ornamental Trees  
<https://www.ornamental-trees.co.uk/>

## *Amelanchier grandiflora* 'Robin Hill'

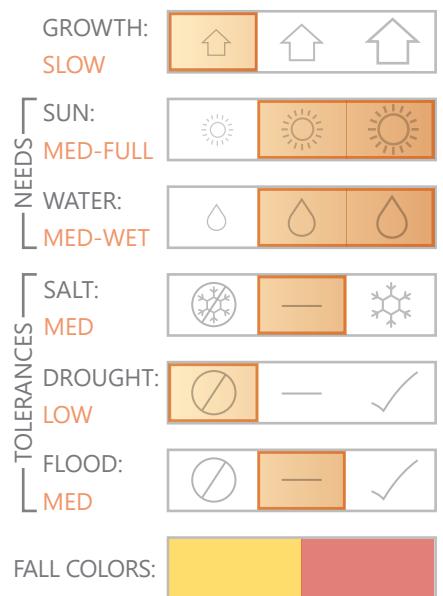
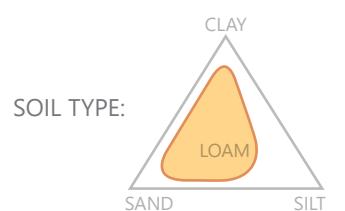
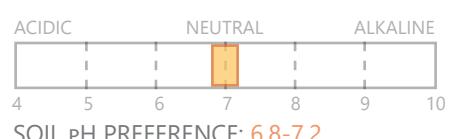
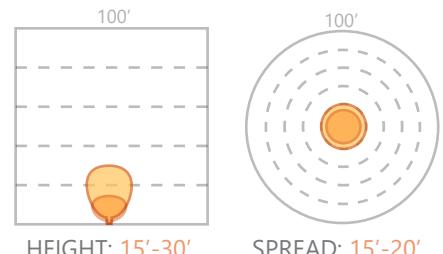
### Robin Hill Serviceberry Rosaceae (Rose Family)

PLANTING NOTES: AVOID PLANTING NEAR EASTERN RED CEDAR / JUNIPERUS VIRGINIANA DUE TO CEDAR-RUST DISEASES

FRUIT: RED, FLESHY AND ROUND

USDA PLANTING RANGE: 4A-7A

FORM: UPRIGHT AND VASE-SHAPED





## *Amelanchier laevis 'Lustre'*

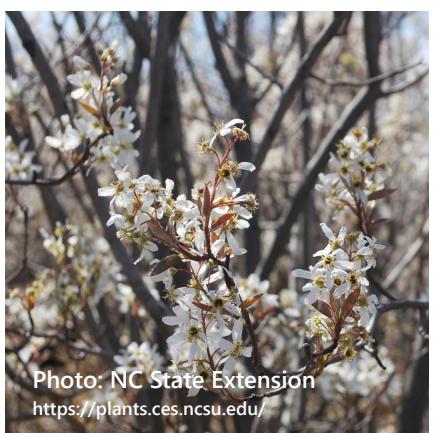
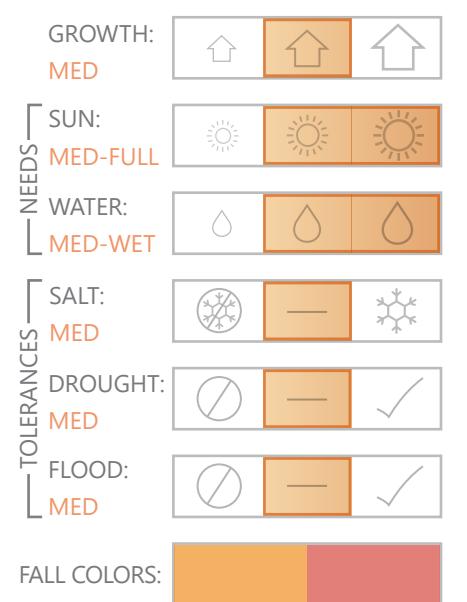
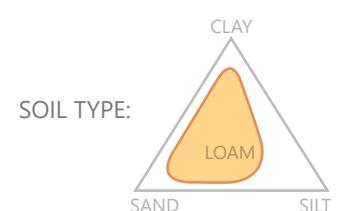
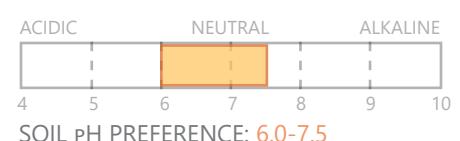
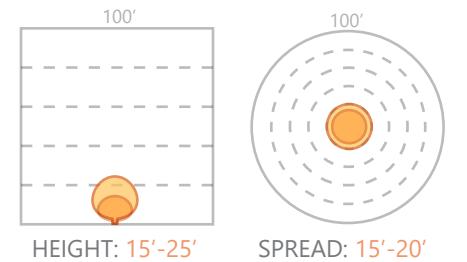
**Lustre Allegheny Serviceberry**  
Rosaceae (Rose Family)

PLANTING NOTES: AVOID PLANTING NEAR EASTERN RED CEDAR / JUNIPERUS VIRGINIANA DUE TO CEDAR-RUST DISEASES

FRUIT: SMALL EDIBLE PURPLE BERRIES

USDA PLANTING RANGE: 4A-8A

FORM: ROUNDED



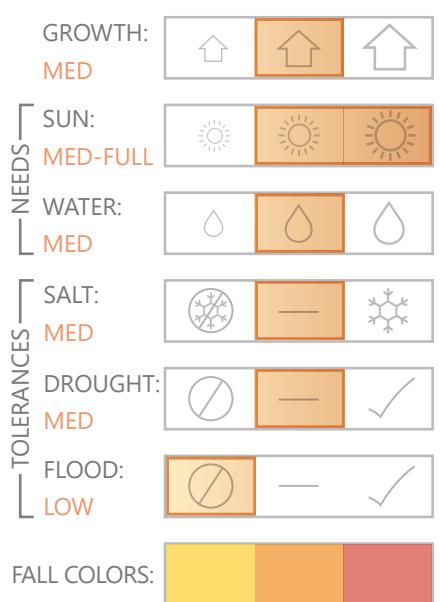
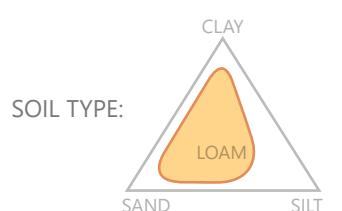
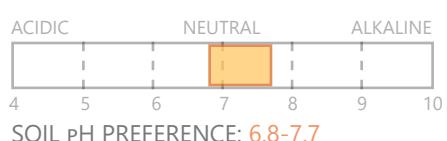
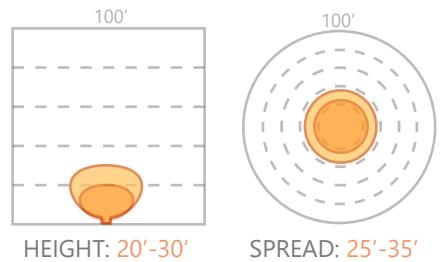
## *Cercis canadensis*

**Eastern Redbud**  
Fabaceae (Pea Family)

FRUIT: BROWN, 2-3" PODS

USDA PLANTING RANGE: 4-9

FORM: ROUNDED TO FLAT-TOPPED





## Cornus florida

### Flowering Dogwood

Cornaceae

(Dogwood Family)

RECOMMENDED CULTIVARS: CHEROKEE  
PRINCESS & APPALACHIAN SNOW

FRUIT: BRIGHT RED BERRIES

USDA PLANTING RANGE: 5A-9A

FORM: ROUNDED

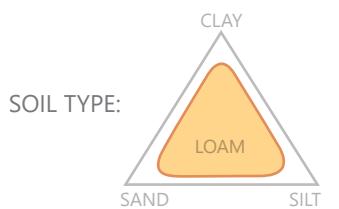
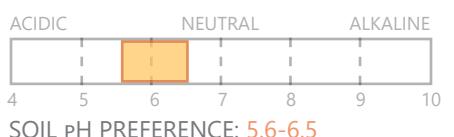
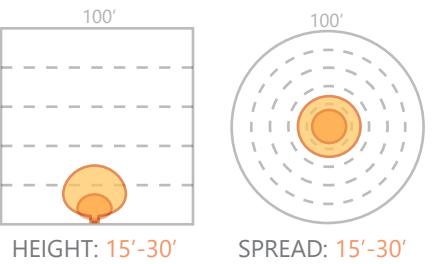


Photo: Green Mile Trees  
<https://www.greenmilетrees.co.uk/>

## Crataegus crus-galli 'Inermis'

### Cockspur Hawthorn

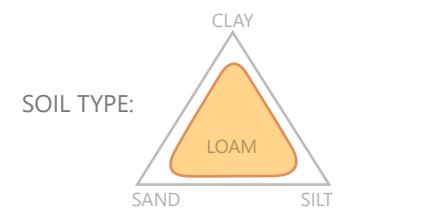
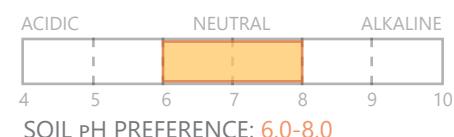
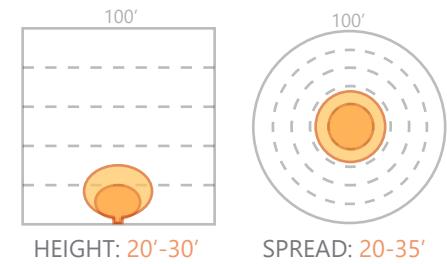
Rosaceae (Rose Family)

PLANTING NOTES: AVOID PLANTING NEAR  
EASTERN RED CEDAR / JUNIPERUS  
VIRGINIANA DUE TO CEDAR-RUST DISEASES

FRUIT: RED/BURGANDY 1/2" POME

USDA PLANTING RANGE: 3A-7A

FORM: ROUNDED

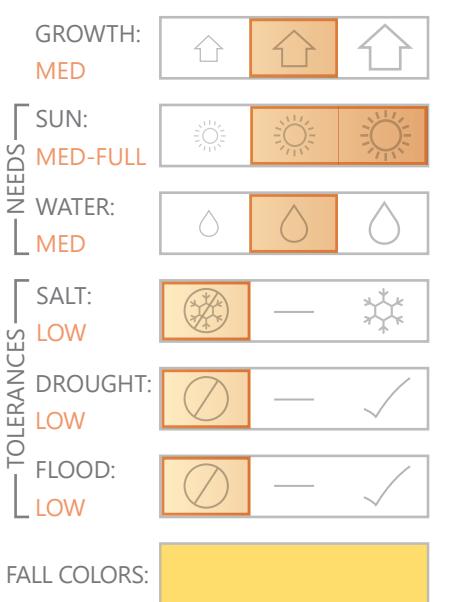
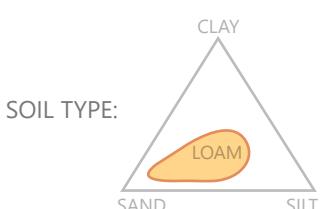
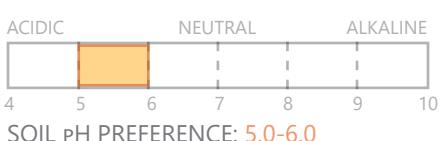
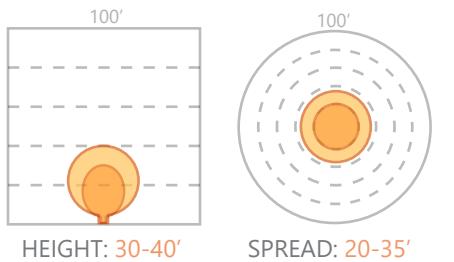




## *Halesia tetrapeta*

**Carolina Silverbell**  
*Styracaceae*  
(Silver Bell Family)

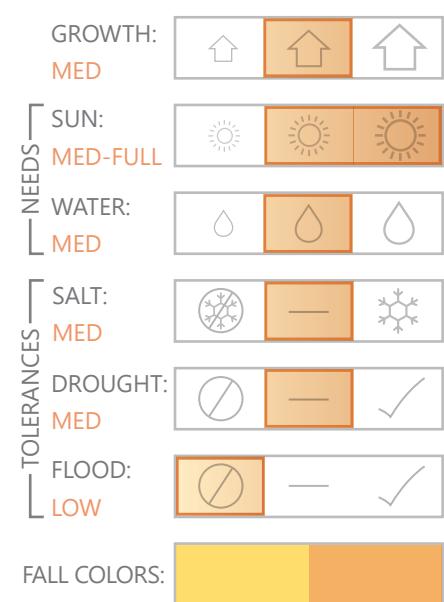
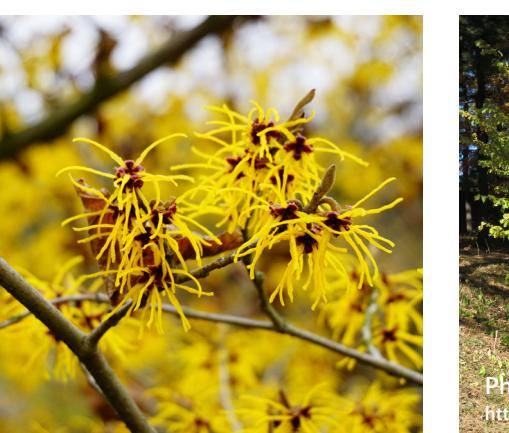
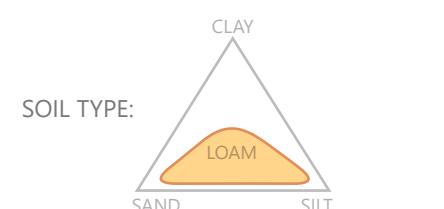
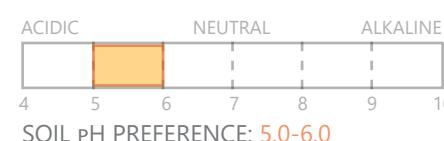
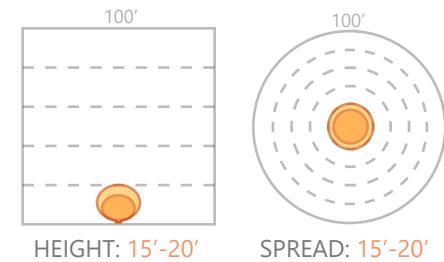
FRUIT: 4-WINGED DRY FRUIT  
USDA PLANTING RANGE: 4-8  
FORM: ROUNDED



## *Hamamelis virginiana*

**Witch-Hazel**  
*Hamamelidaceae*  
(Witch-Hazel Family)

FRUIT: 1/2" HARD WOODY CAPSULE  
USDA PLANTING RANGE: 3-8  
FORM: SHRUBBY





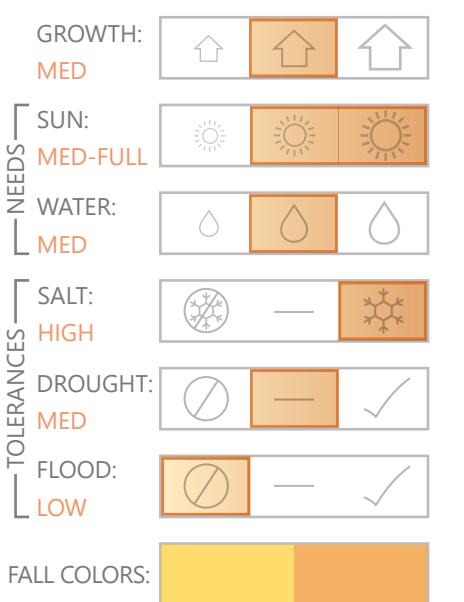
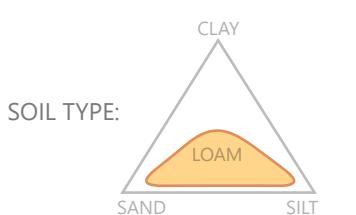
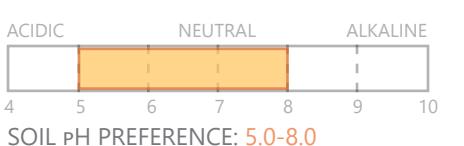
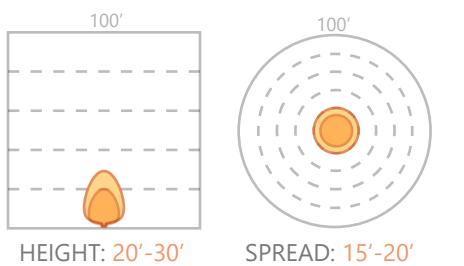
## *Prunus virginiana* **'Schubert'**

**Canada Red Chokecherry**  
 Rosaceae (Rose Family)

FRUIT: DARK PURPLE/BLACK FRUIT

USDA PLANTING RANGE: 2-6

FORM: PYRAMIDAL



## Evergreen Trees

The following trees are recommended for use as visual screens or wind breaks, as well as specimen trees in lawn or park areas. More specific information for each tree can be found on the following pages.

Botanical Name	Common Name	Uses
		STREET TREE
		UNDER POWER LINES
<i>Abies balsamea</i>	Balsam Fir	
<i>Abies concolor</i>	White Fir	
<i>Picea glauca</i>	White Spruce	
<i>Pinus rigida</i>	Pitch Pine	
<i>Pinus strobus 'Fastigiata'</i>	Eastern White Pine	
<i>Ilex opaca</i>	American Holly	



## *Abies balsamea*

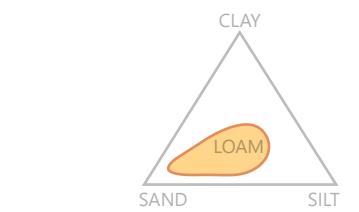
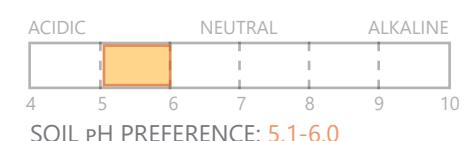
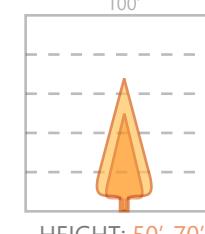
### Balsam Fir

Pinaceae (Pine Family)

FRUIT: CONES UPRIGHT ON BRANCHES

USDA PLANTING RANGE: 3A-6B

FORM: CONICAL



GROWTH: MED



SUN: MED-FULL



WATER: MED



SALT: LOW



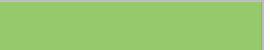
DROUGHT: LOW



FLOOD: HIGH



FALL COLORS:





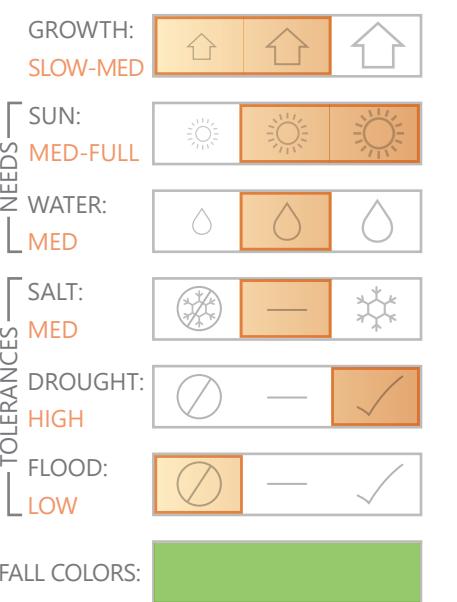
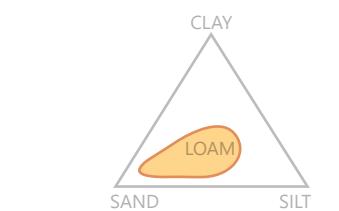
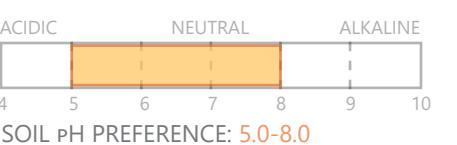
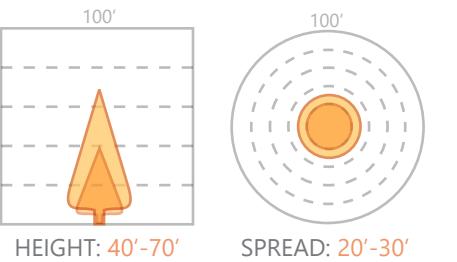
## Abies concolor

**White Fir**  
Pinaceae (Pine Family)

FRUIT: CONES UPRIGHT ON BRANCHES

USDA PLANTING RANGE: 3-7

FORM: CONICAL



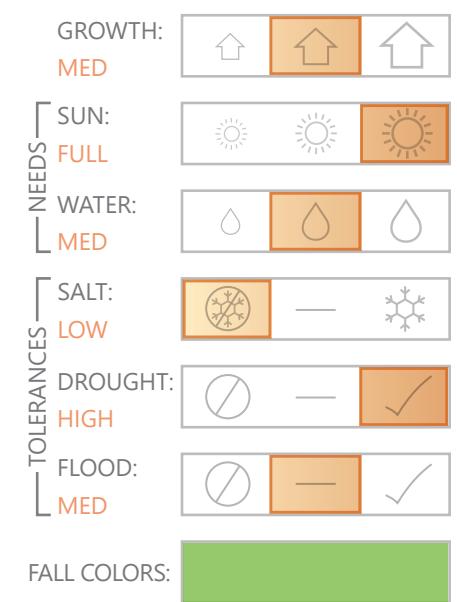
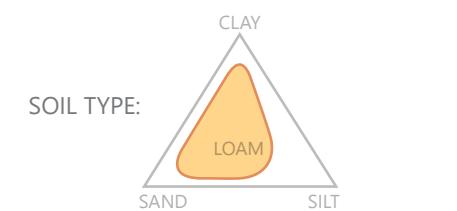
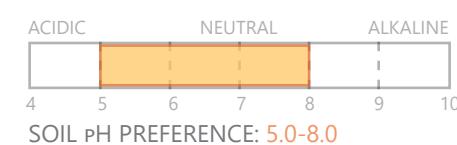
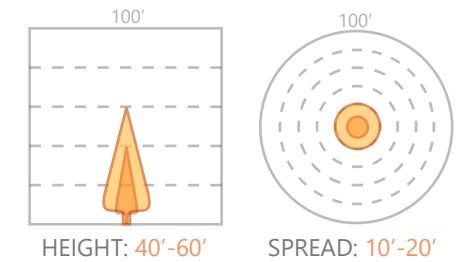
## Picea glauca

**White Spruce**  
Pinaceae (Pine Family)

FRUIT: CYLINDRICAL BROWN CONES

USDA PLANTING RANGE: 2-6

FORM: CONICAL





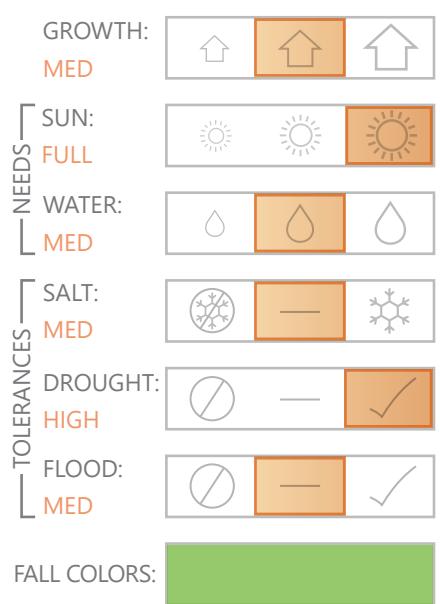
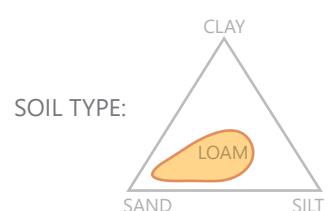
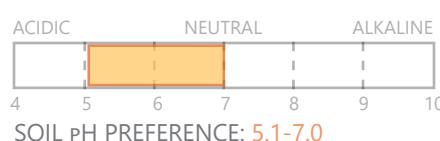
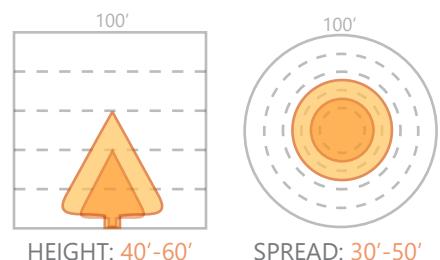
## *Pinus rigida*

**Pitch Pine, Black Pine**  
*Pinaceae* (Pine Family)

FRUIT: 1"-3" LIGHT BROWN CONES

USDA PLANTING RANGE: 4B-7A

FORM: CONICAL



## *Pinus strobus*

**'Fastigiata'**

**Fastigate Eastern White Pine**  
*Pinaceae* (Pine Family)

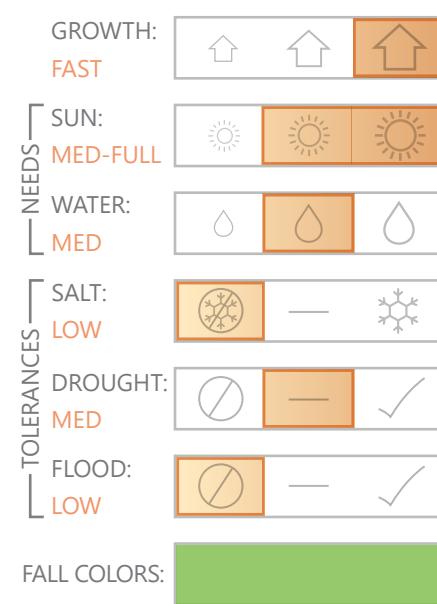
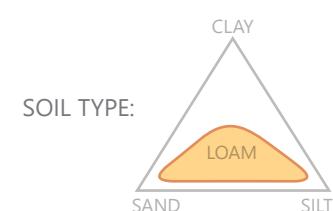
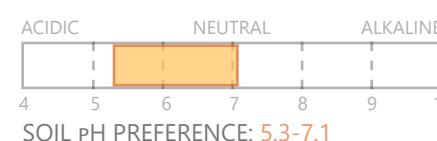
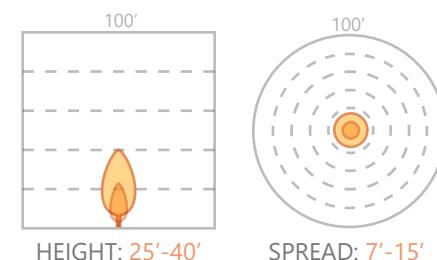


Photo: Jersey-Friendly Yards  
<https://www.jerseyyards.org/>



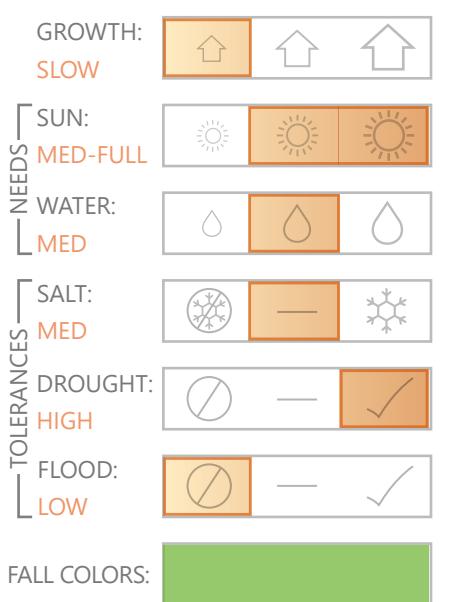
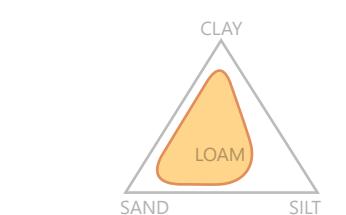
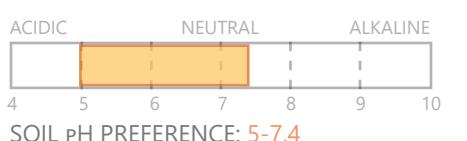
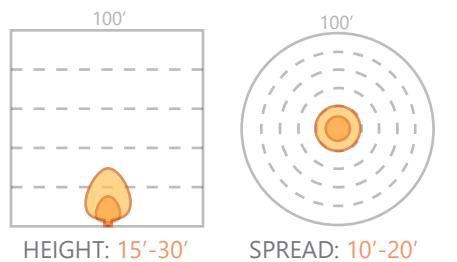
## *Ilex opaca*

**American Holly**  
*Aquifoliaceae* (Holly Family)

FRUIT: SMALL RED BERRIES

USDA PLANTING RANGE: 5-9

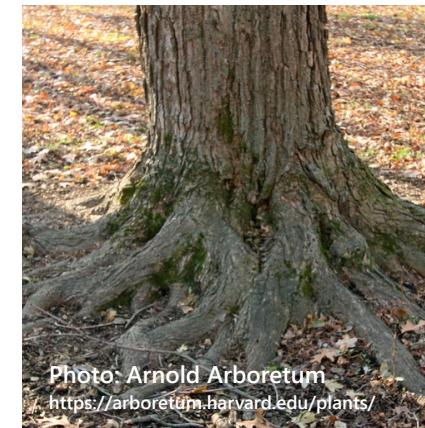
FORM: PYRAMIDAL



## Specimen Trees

The following trees are recommended for use in lawn and park areas set well back from sidewalks and roadsides along the outside of the public right of way. More specific information for each tree can be found on the following pages.

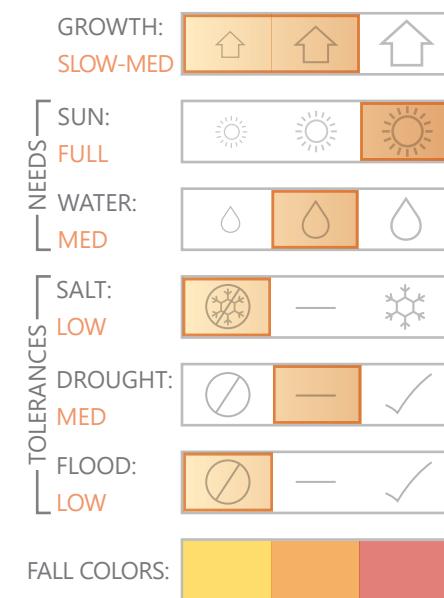
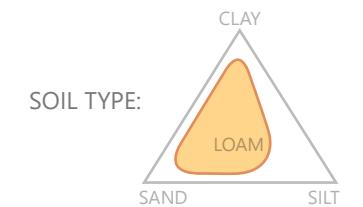
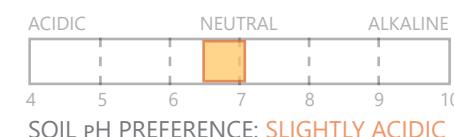
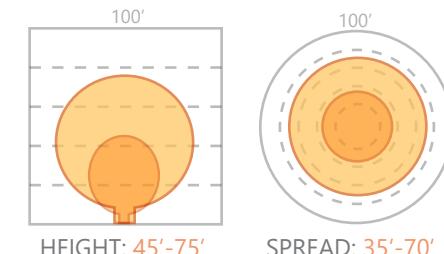
Botanical Name	Common Name	Uses
		STREET TREE      UNDER POWER LINES
<i>Acer saccharum</i>	Sugar Maple	
<i>Amelanchier laevis</i> 'Clump'	Clump Allegheny Serviceberry	 
<i>Betula nigra</i>	River Birch	
<i>Carpinus caroliniana</i>	American Hornbeam (Musclewood)	 
<i>Liriodendron tulipifera</i>	Tuliptree	
<i>Magnolia virginiana</i>	Sweetbay Magnolia	 
<i>Tilia americana</i>	Basswood	



## *Acer saccharum*

**Sugar Maple**  
*Aceraceae* (Maple Family)

FRUIT: BROWN  
USDA PLANTING RANGE: 3-9  
FORM: OVAL TO ROUND





## *Amelanchier laevis 'Clump'*

**Clump Allegheny**

**Serviceberry**

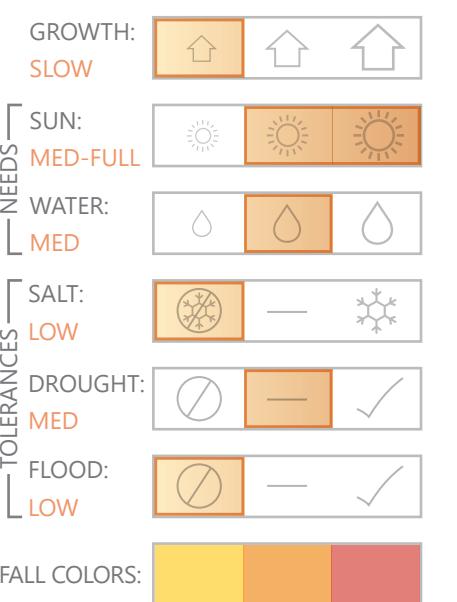
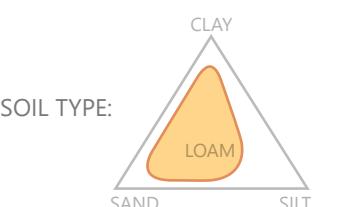
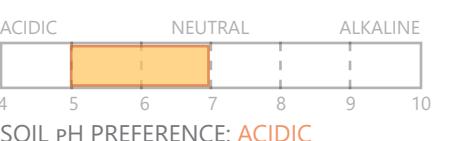
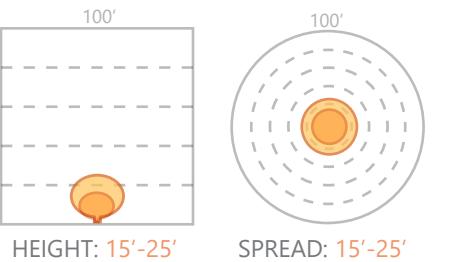
**Rosaceae (Rose Family)**

PLANTING NOTES: AVOID PLANTING NEAR  
EASTERN RED CEDAR / JUNIPERUS  
VIRGINIANA DUE TO CEDAR-RUST DISEASES

FRUIT: BLACK

USDA PLANTING RANGE: 4-8

FORM: ROUNDED



## *Betula nigra*

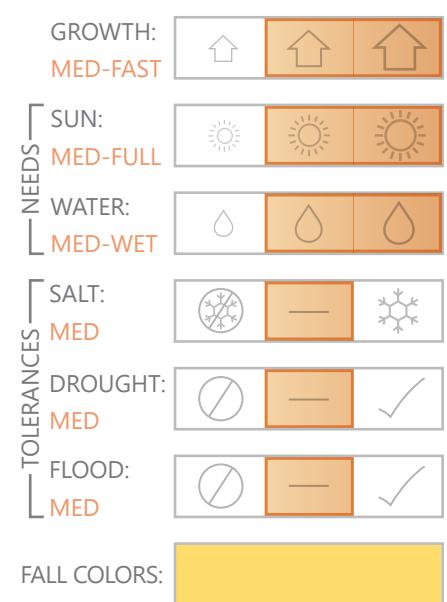
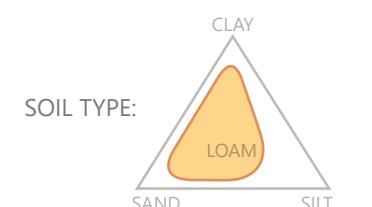
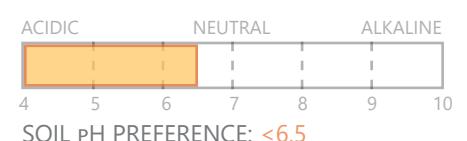
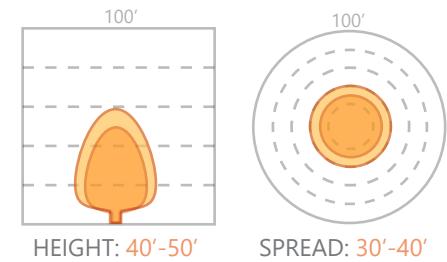
**River Birch**

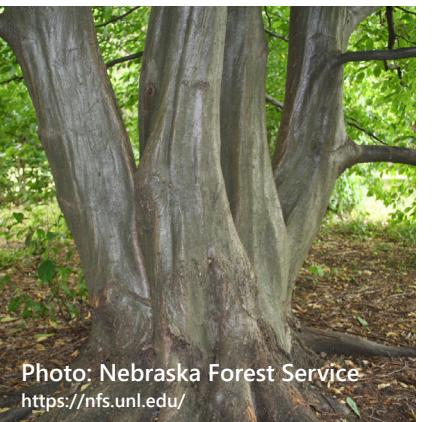
**Betulaceae (Birch Family)**

FRUIT: BROWN

USDA PLANTING RANGE: 4-9

FORM: PYRAMIDAL TO OVAL





## *Carpinus caroliniana*

American Hornbeam,  
Musclewood  
Betulaceae (Birch Family)

FRUIT: GREEN

USDA PLANTING RANGE: 3-9

FORM: ROUNDED

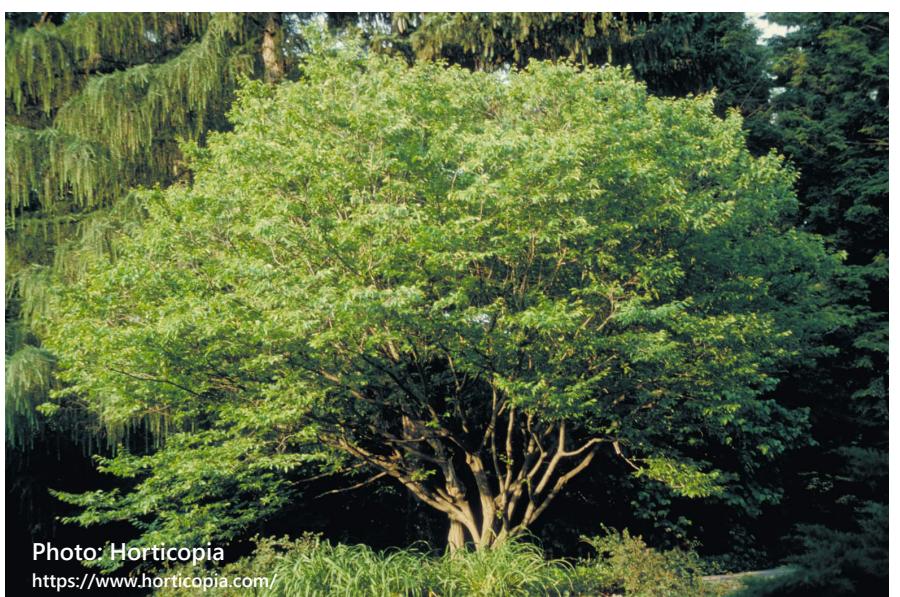
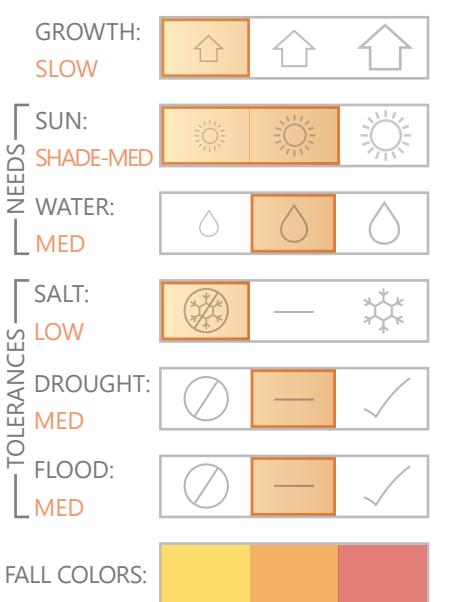
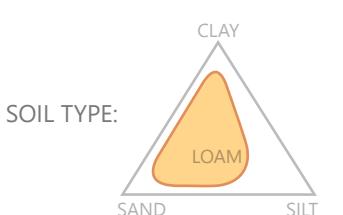
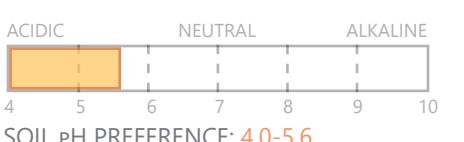
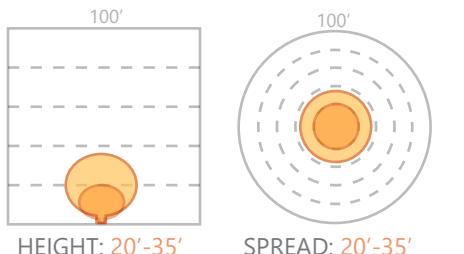


Photo: Horticopia  
<https://www.horticopia.com/>



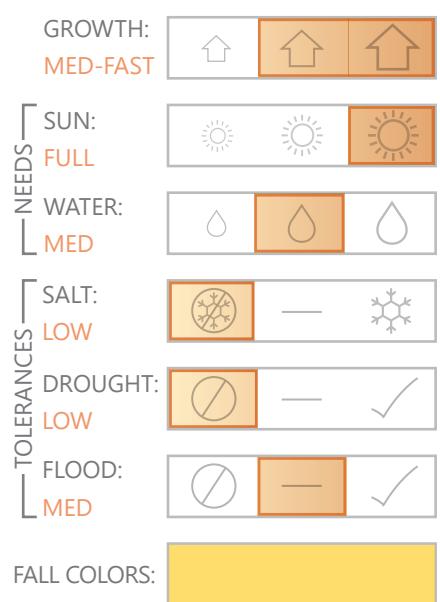
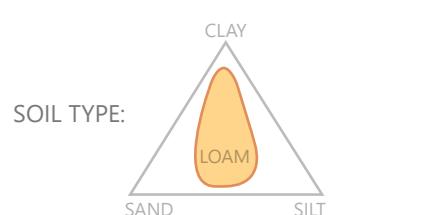
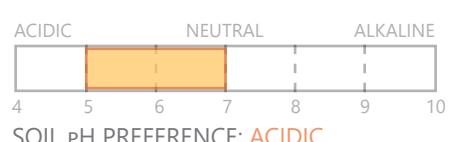
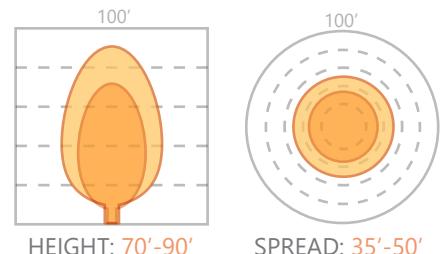
## *Liriodendron tulipifera*

Tuliptree, Tulip Poplar  
Magnoliaceae  
(Magnolia Family)

FRUIT: BROWN

USDA PLANTING RANGE: 4-9

FORM: PYR. (YOUNG) OVAL (MATURE)





## 2.2

### Tree Types to Avoid

There are many reasons to avoid certain trees. Some trees are invasive (as discussed earlier), but other reasons you may avoid certain trees are weak wood, unpleasant flower/fruit scents, messy fruit/branches/leaves, trees prone to insects/disease, etc.

Two trees worth avoiding for these reasons:



#### Pyrus / Pear trees

In general *Pyrus calleryana* and their cultivars are fast growing trees which results in weak wood. This is a problem, especially in New England where we get heavy snows, as the branches often break in storms and cause damage to cars, wires, and homes.

*Pyrus calleryana* 'Bradford' trees were extremely popular street and yard trees in the mid 1900s as they produce beautiful flowers in the Spring, have attractive leaf color in the Fall, and are fairly inexpensive and fast growing. Bradford Pears were bred from seed from China in the hopes of increasing disease resistance among pear trees, and were meant to be sterile. It turned out that they were not sterile, and, especially in the South, have escaped cultivation and often show varying characteristics such as thorns, dense canopies, and prolific fruiting which speeds their spread.

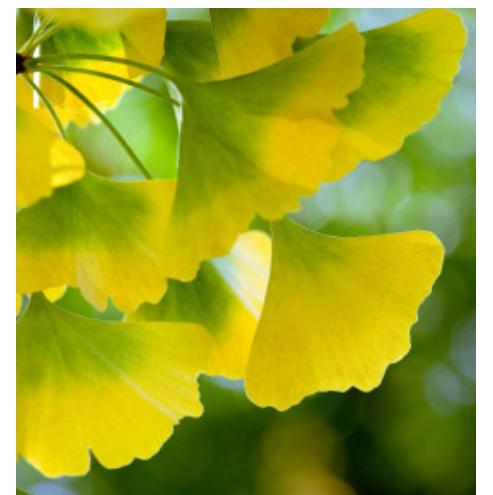
Even recent cultivars are believed to cross-pollinate with other cultivars to create trees of varying characteristics. This is dangerous as these strong trees often overtake landscapes composed of native plants, reducing their habitat. Many states have placed *Pyrus calleryana* cultivars on invasive species lists and do not allow them in commerce. Therefore because of their potentially invasive tendency, overuse in built landscapes, and high rate of broken limbs they are strongly discouraged in Littleton, MA.



#### Ginkgo biloba / Ginkgo tree

*Ginkgo biloba* is indeed a beautiful tree with a unique leaf shape and vibrant yellow fall color. It is also a prehistoric tree, with fossil records dating back about 270 million years. It is tolerant in the types of soils it lives in and is relatively free of insect and disease pests. The trees are also dioecious, meaning there are separate male and female trees.

The down side to *Ginkgo* trees is that the seeds of female trees are not only messy but have quite a bad smell. However, many nurseries do carry cultivars that are only males (Princeton Sentry, Magyar and Autumn Gold) and therefore will not produce messy and smelly seeds.



Most importantly there are discussions around the noted lack of wildlife value of the tree, arguing that it hosts no native birds or pollinators, and only one species of caterpillar. In areas of extremely adverse planting conditions, such as cities, the *Ginkgo* is often a good choice. However, there are many other native tree options that would work well in difficult urban conditions that would provide value to wildlife. For these reasons the use of *Ginkgo biloba* outside of residential ornamental collections is discouraged in Littleton, MA.

Other suggested trees to avoid:

- *Fraxinus spp.* / Ash - highly susceptible to Emerald Ash Borer
- *Tsuga canadensis* / Eastern Hemlock - highly susceptible to Hemlock Woolly Adelgid and our area is becoming too warm for its survival



3

## Installation and Maintenance

3.1

## Homeowner/Developer Guidelines

These guidelines do not exempt applicants from obtaining all required permits and complying with applicable bylaws and regulations.

## Shopping Guidelines

When shopping for a tree at a nursery there are a few key aspects to look for in a healthy tree. Inspect the tree trunk and make sure there are no large wounds, gashes, or insect holes. Follow the trunk up into the canopy and make sure there is one main branch (leader); a split leader is more prone to breakage in the future. If there are excessive amounts of branches crossing and rubbing against each other look for a different specimen. Stand back and look at the canopy and branches, and walk around the tree to make sure it looks symmetrical and full. Look at the rootball in the pot or burlap and make sure it's not broken in pieces and there are no roots circling around the trunk.

## Screening Options

When using evergreen trees as a hedge or visual screen, it is best to avoid a "row of soldiers" style monoculture of the same species repeated in a line. Not only might you lose them all should any one get a disease, but visually it's not very interesting.



Instead, use a variety of evergreen species of varying heights and textures in your screen. This ensures that your screen will have a higher chance of surviving diseases/pests and will provide a greater variety of food and habitat to local wildlife. If you do not need year-round visual screening, try adding in some deciduous plants for increased environmental value.

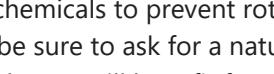


## Installation Details

It is recommended to avoid planting trees when the ground is frozen as well as during the extreme heat of summers. Ideal times to plant deciduous trees are April 1st – June 15th and October 1st – November 1st. For evergreen trees the best time to plant is April 1st – June 1st and September 1st to November 15th. Additionally, do not plant or dig when the ground is wet as the ground is more easily compacted and the sides of a hole can become glazed, preventing the easy growth and expansion of the root system.

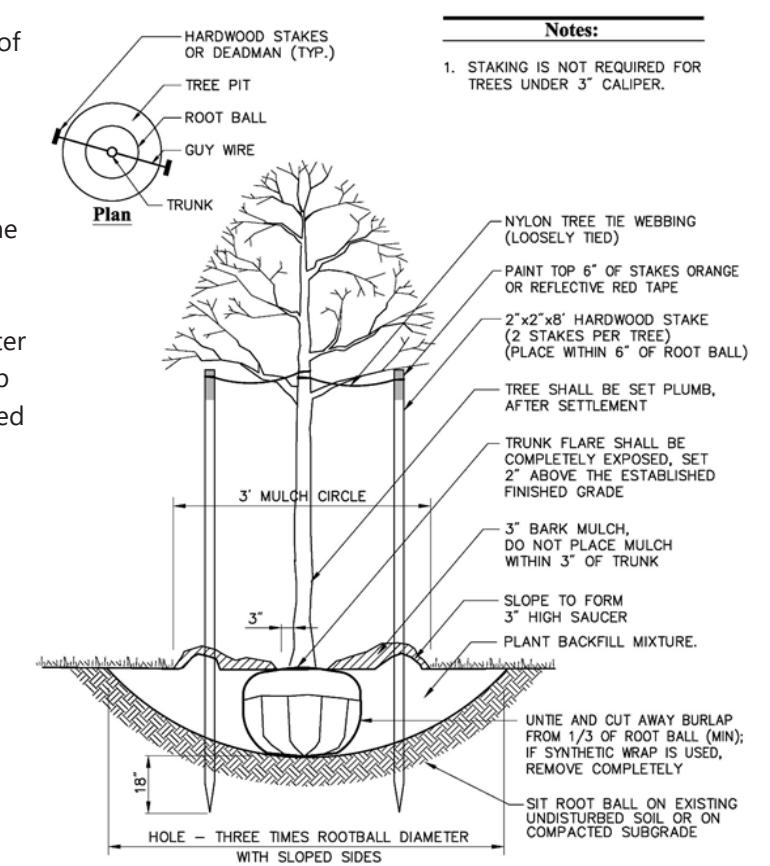
Follow the planting detail below. For smaller trees remove all burlap and metal caging if possible to do so without breaking the root ball. The plant backfill mixture should be 75% existing soil and 25% compost for homeowners, and 50% new topsoil/loam with 25% existing soil and 25% compost for contractors.

For mulch, consider using a natural un-dyed mulch. Dyed mulch not only looks unnatural, but can be made from recycled wood products of unknown origins. This recycled wood could have been treated with harmful chemicals to prevent rotting or insect damage, and that could enter your landscape. Therefore be sure to ask for a natural un-dyed mulch, this way as it decomposes your plants and landscape will benefit from its nutrients. When mulching, be especially sure to keep the mulch away from the trunks of trees and shrubs as this promotes trunk rot and poor root structure.



**Notes:**

1. STAKING IS NOT REQUIRED FOR TREES UNDER 3" CALIPER.



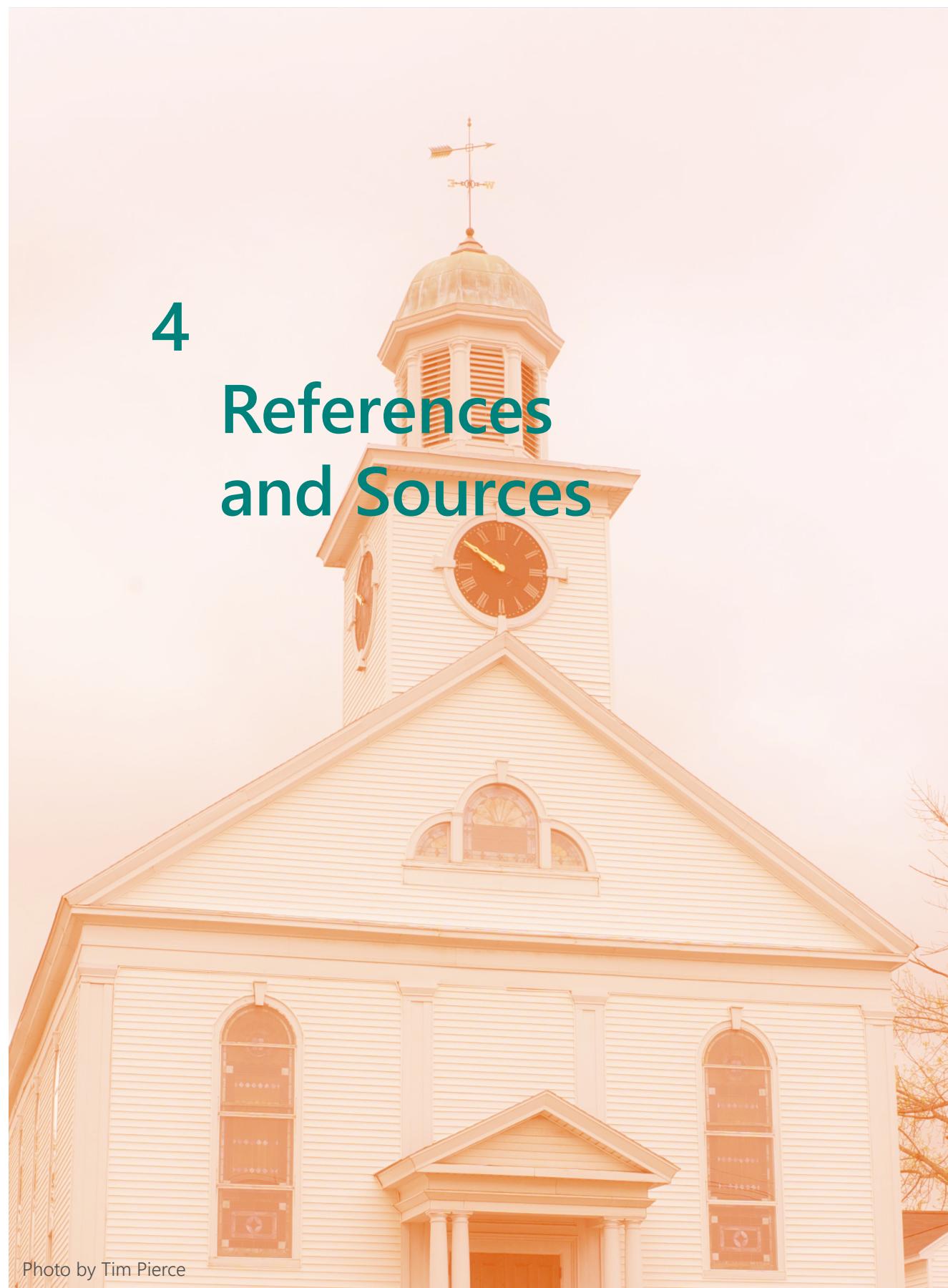
## Tree planting (For Trees Under 4" Caliper)

## Maintaining

The first year is critical for establishment. Plants need an average of 1" of rain/water a week to maintain health, so be sure to supplement with hand watering the first year when there is not enough rain. For a 2" tree that means watering with about 15 gallons of water per week. It is best to separate the waterings into a few slow and long sessions as this lets the water penetrate the soil deeper therefore encouraging strong roots to grow deeper. After the first year in the ground, continue to monitor the tree's health during droughts by looking for drooping leaves as a sign of drought stress.

As the tree grows, pruning may become necessary. Horticulturalists are well trained to prune trees, so if in doubt give one a call to assess your tree. On your own you can feel confident to remove broken branches or cut out dead limbs. Always use clean and sharp pruners or saws. Cuts should be made perpendicular to the branch when possible to minimize the amount of healing the tree will have to do. If a ladder is needed, follow proper ladder safety measures, especially when handling sharp tools. Pruning is most often done in late winter when the tree is dormant and the sap is no longer flowing. However, it may be better to research your particular tree for suggested pruning times. Again, horticulturalists or tree companies will be able to assess trees for you and suggest the best course of action for your particular situation.

For more information on caring for new trees you can refer to: <https://www.maurbancanopy.org/wp-content/uploads/2020/02/Tree-Care-Brochure-FIN-REV-1-Digital.pdf>



# 4

## References and Sources

### 4.1

#### References & Sources

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