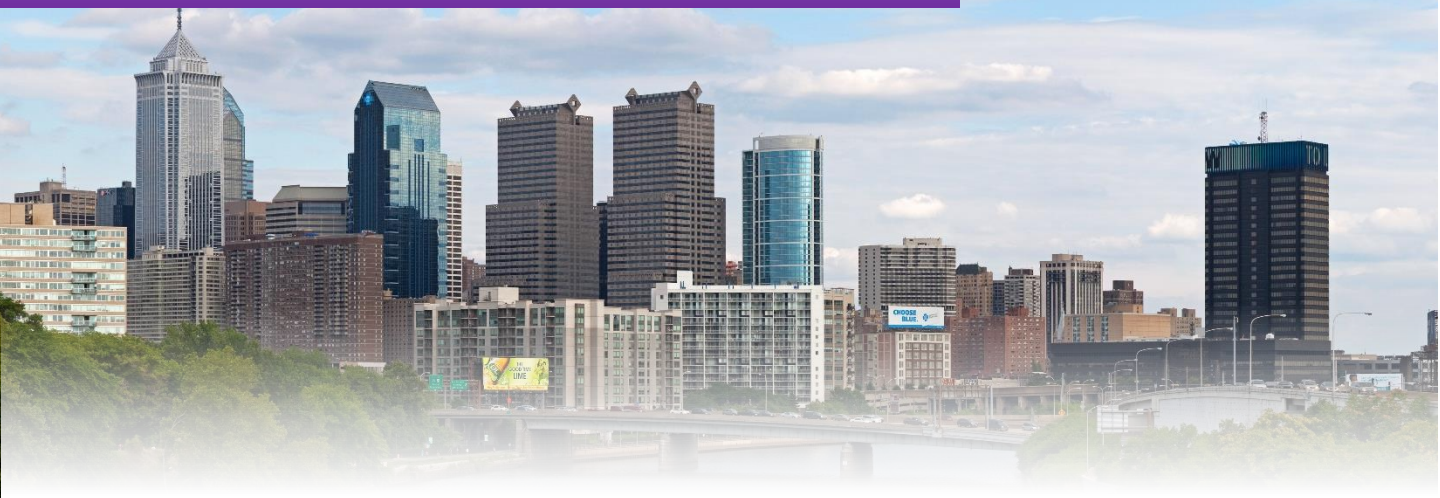


# Philadelphia Region

## *Urban Forest Impacts and Vulnerabilities*



Urban forests play an important role in helping communities adapt to and mitigate climate change because they reduce the urban heat island effect, control stormwater, and store carbon.

Despite this, few urban areas have examined the vulnerability of their trees to current and future climate conditions or developed specific adaptation plans to ensure that their urban forests continue to provide benefits into the future.

Urban forests will experience local climate change impacts in the coming decades. A key first step to adapting to these changes is understanding the potential impacts and vulnerabilities of the urban forest.

As part of the Urban Forestry Climate Change Response Framework, we synthesize the best available science about local climate change impacts and what that means for urban trees and ecosystems. Learn more about other project activities at:

[www.forestadaptation.org/urban](http://www.forestadaptation.org/urban)

## The climate has changed

Since 1948, the Philadelphia region has warmed by about 0.4°F per decade on average, with more warming occurring at night, especially in the winter.

The sea level around Philadelphia has been rising at a rate of roughly 0.11 inches per year since 1900, equivalent to an increase of nearly one foot in 100 years.

The area is also getting wetter. The greatest increases have been in the spring, and more precipitation is falling as heavy rain events.

The Philadelphia region is getting warmer and wetter, and sea level is rising.



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# Philadelphia Region

## Urban Forest Impacts and Vulnerabilities

How may the Philadelphia region's climate change in the coming decades? Researchers use global climate models to help us understand projected changes in climate under a range of potential future greenhouse gas emissions.

### Temperatures will increase

All global climate models project that temperatures will increase in the Philadelphia region. Model projections suggest an increase in temperature over the next century across all seasons by 2 to 10°F. Growing seasons will continue to lengthen due to warmer temperatures, and winter temperatures in particular are projected to increase.

### Sea level will rise

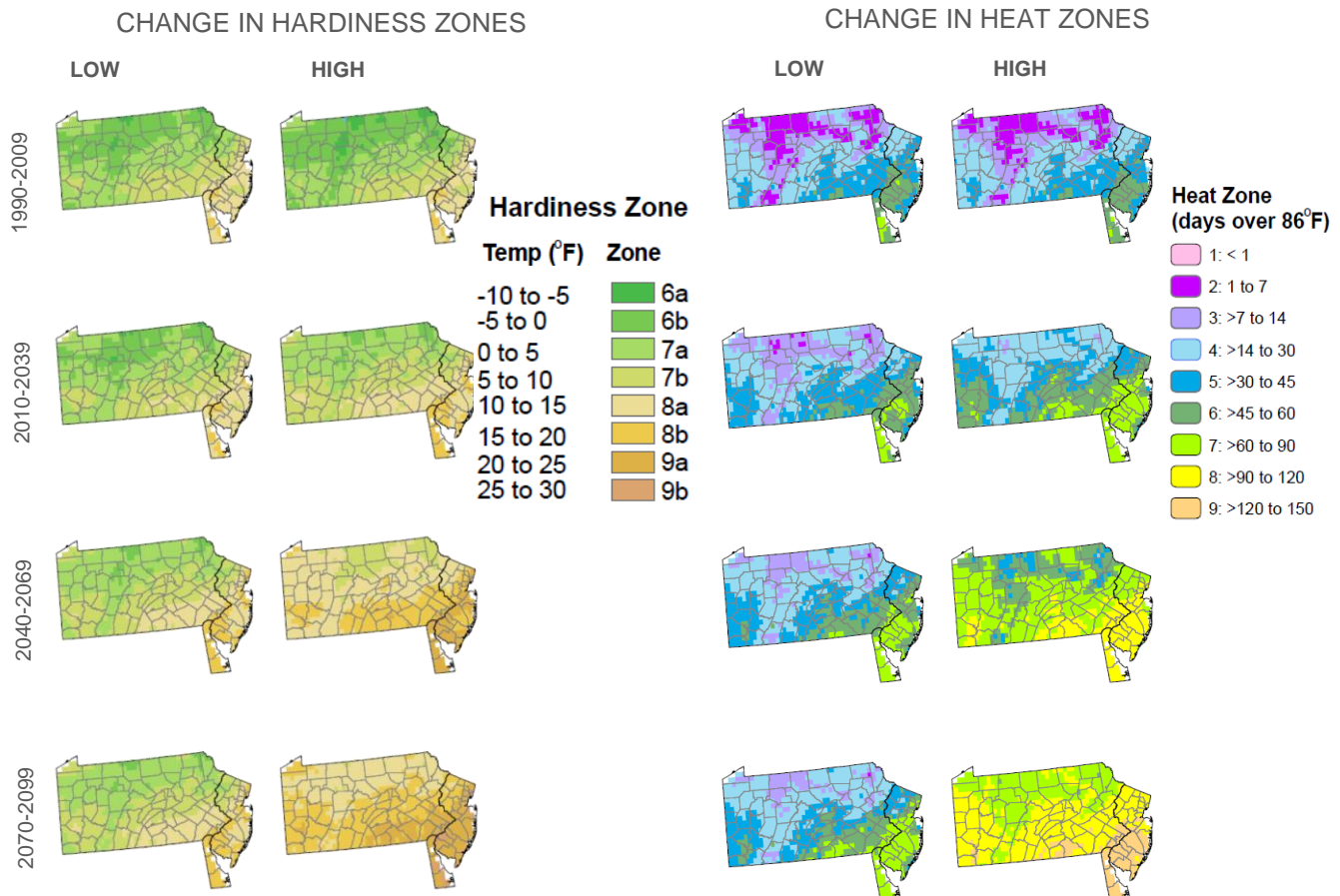
By the 2080s, sea level in the Philadelphia region could rise between 1 and 4.5 feet. Coupled with storm surge, severe flooding could occur across large portions of the metropolitan area.

### Precipitation will change

Precipitation is projected to increase in winter and spring and potentially decrease in the summer or fall. Models suggest the frequency of heavy rain events may increase, and more winter precipitation may happen as rain or sleet rather than snow.

### Shifting heat and hardiness zones

Planting suitability for trees and other plants is determined by hardiness zones, which are based on minimum temperatures, and heat zones, which are based on the number of days above 86°F. Both heat and hardiness zones are projected to shift over the next century, changing what can be planted.



Projected changes in hardiness zones and heat zones under a low (dramatic reduction in emissions) and high (business as usual) greenhouse gas emission scenario for 30-year periods in Minnesota.

# Philadelphia Region

## Urban Forest Impacts and Vulnerabilities

### Effects on Philadelphia's urban trees

Trees in the Philadelphia area will be affected by changing temperatures and precipitation patterns. Warmer summers can create stress for some species that cannot tolerate high temperatures. Milder winters may allow some species to survive in the area that previously would have suffered freezing damage. Warmer springs and falls may change the timing of leaf-out, flowering, and senescence.

Precipitation patterns will also affect local trees. More heavy precipitation events may increase the frequency or severity of flooding. Sea level rise and storm surge can lead to increased salinity in addition to causing flooding. Storms may break limbs or damage trees. Drier conditions in summer or fall coupled with warmer temperatures could cause soil moisture deficits.

A changing climate can also affect the range and severity of pests, diseases, and invasive plant species. These biological stressors can also affect the survival and health of urban trees.

Some species will be more vulnerable to these changes than others. The species listed here were assessed for changes in species habitat suitability from climate impacts models and heat and hardiness zones. Traits that may make species more adaptable to stress, such as resistance to pests, diseases, drought, and flooding were also considered.<sup>a</sup>

These lists highlight species that may be more or less vulnerable to projected changes in the climate and other stressors in the coming decades. Some vulnerable species may still be an important part of the landscape; they just may require extra care or specific planting sites. Species vulnerability is meant to be considered along with other managements goals, such as enhancing biodiversity or providing wildlife habitat.

| Low Vulnerability:<br><i>Adapted to future climate and a range of other stressors</i> |                             |                              |
|---|-----------------------------|------------------------------|
| Latin Name  | Common Name                 | Number of Trees <sup>d</sup> |
| <i>Ailanthus altissima</i>  | Tree-of-heaven <sup>i</sup> | 183,180                      |
| <i>Celtis occidentalis</i>  | Hackberry                   | 7,200                        |
| <i>Diospyros virginiana</i>   | Common persimmon            | 5,070                        |
| <i>Hibiscus syriacus</i>  | Rose-of-Sharon              | 7,200                        |
| <i>Ilex opaca</i>   | American holly              | 16,780                       |
| <i>Nyssa sylvatica</i>  | Blackgum                    | 50,340                       |
| <i>Paulownia tomentosa</i>  | Princesstree <sup>i</sup>   | 22,370                       |
| <i>Ulmus parviflora</i>   | Chinese elm <sup>i</sup>    | 13,420                       |
| <i>Zelkova serrata</i>  | Japanese zelkova            | 7,200                        |

| Low-Moderate Vulnerability:<br><i>Adapted to future climate and most stressors</i> |                             |                 |
|--|-----------------------------|-----------------|
| Latin Name   | Common Name                 | Number of Trees |
| <i>Acer pseudoplatanus</i>   | Sycamore maple              | 29,570          |
| <i>Acer rubrum</i>   | Red maple                   | 101,220         |
| <i>Aesculus hippocastanum</i>  | Horsechestnut               | 17,860          |
| <i>Betula nigra</i>  | River birch                 | 7,200           |
| <i>Cornus florida</i>  | Flowering dogwood           | 7,200           |
| <i>Gleditsia triacanthos</i>   | Honeylocust                 | 68,160          |
| <i>Malus spp.</i>  | Crabapple species           | 67,120          |
| <i>Morus alba</i>  | White mulberry <sup>i</sup> | 92,410          |
| <i>Pinus nigra</i>   | Austrian pine               | 15,200          |
| <i>Platanus occidentalis</i>   | American sycamore           | 42,990*         |
| <i>Pyrus calleryana</i>  | Callery pear <sup>i</sup>   | 5,070           |
| <i>Quercus coccinea</i>  | Scarlet oak                 | 27,960          |
| <i>Quercus marilandica</i>   | Blackjack oak               | 11,190          |
| <i>Quercus palustris</i>   | Pin oak                     | 16,780          |
| <i>Quercus rubra</i>   | Red oak                     | 106,340         |
| <i>Rhus typhina</i>  | Staghorn sumac              | 87,920          |
| <i>Ulmus pumila</i>  | Siberian elm <sup>i</sup>   | 7,200           |
| <i>Ulmus rubra</i>   | Slippery elm                | 27,960          |

<sup>a</sup>Methods used for determining vulnerability can be found in Brandt et al. 2017. Chicago Wilderness region urban forest vulnerability assessment and synthesis: a report from the Urban Forestry Climate Change Response Framework Chicago Wilderness pilot project. Gen. Tech. Rep. NRS-168. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 142 p.

<sup>d</sup>Data is estimated for the city of Philadelphia from Nowak et al. 2016. The urban forests of Philadelphia. Resource Bulletin NRS-106. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 80 p.

<sup>i</sup> non-native invasive species considered harmful to natural ecosystems

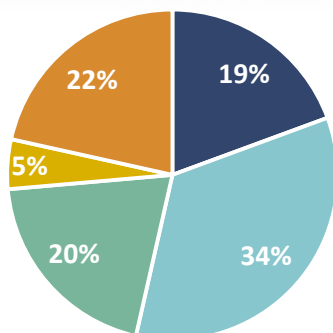
\*Estimate is for the *Platanus* genus.



# Philadelphia Region

## Urban Forest Impacts and Vulnerabilities

### Percent trees in each vulnerability category



- low
- low-moderate
- moderate
- moderate-high
- high

Confronting the challenge of climate change presents opportunities for land managers to plan ahead, foster resilient landscapes, and ensure that the benefits that forests provide are sustained into the future.

Resources are available to help forest managers and planners incorporate climate change considerations into forest management. A set of Forest Adaptation Resources is available at [www.forestadaptation.org](http://www.forestadaptation.org).

#### Moderate Vulnerability:

*May experience some stress from climate change or other stressors*

| Latin Name                    | Common Name               | Number of Trees |
|-------------------------------|---------------------------|-----------------|
| <i>Acer negundo</i>           | Boxelder                  | 176,400         |
| <i>Acer platanoides</i>       | Norway maple <sup>i</sup> | 73,580          |
| <i>Acer saccharinum</i>       | Silver maple              | 5,590           |
| <i>Chamaecyparis thyoides</i> | Atlantic white cedar      | 21,610          |
| <i>Crataegus viridis</i>      | Green hawthorn            | 5,590           |
| <i>Juglans nigra</i>          | Black walnut              | 57,540          |
| <i>Morus rubra</i>            | Red mulberry              | 5,590           |
| <i>Quercus alba</i>           | White oak                 | 20,000          |
| <i>Quercus prinus</i>         | Chestnut oak              | 5,070           |
| <i>Quercus velutina</i>       | Black oak                 | 5,590           |
| <i>Salix nigra</i>            | Black willow              | 19,010          |
| <i>Thuja occidentalis</i>     | Northern white-cedar      | 142,060         |

#### Moderate-High Vulnerability:

*Will likely experience considerable stress from climate or other stressors*

| Latin Name                     | Common Name               | Number of Trees |
|--------------------------------|---------------------------|-----------------|
| <i>Acer palmatum</i>           | Japanese maple            | 21,610          |
| <i>Betula lenta</i>            | Sweet birch               | 5,590           |
| <i>Fagus sylvatica</i>         | European beech            | 7,200           |
| <i>Hamamelis virginiana</i>    | American witchhazel       | 16,780          |
| <i>Liriodendron tulipifera</i> | Tulip tree                | 27,960          |
| <i>Picea glauca</i>            | White spruce              | 7,200           |
| <i>Platanus x acerifolia</i>   | London planetree          | 42,990*         |
| <i>Robinia pseudoacacia</i>    | Black locust              | 11,190          |
| <i>Sassafras albidum</i>       | Sassafras                 | 11,190          |
| <i>Tilia americana</i>         | American basswood/ linden | 21,610          |

#### High Vulnerability:

*Will likely experience severe declines from climate or other stressors*

| Latin Name                                   | Common Name        | Number of Trees        |
|--|--------------------|------------------------|
| <i>Betula populifolia</i>                    | Gray birch         | 12,800                 |
| <i>Catalpa speciosa</i>                      | Northern catalpa   | 19,010                 |
| <i>Fagus grandifolia</i>                     | American beech     | 55,930                 |
| <i>Fraxinus americana</i> <sup>EAB</sup>     | White ash          | 207,000 (both species) |
| <i>Fraxinus pennsylvanica</i> <sup>EAB</sup> | Green ash          |                        |
| <i>Pinus strobus</i>                         | Eastern white pine | 13,910                 |
| <i>Populus grandidentata</i>                 | Bigtooth aspen     | 5,590                  |
| <i>Prunus serotina</i>                       | Black cherry       | 241,290                |
| <i>Tsuga canadensis</i>                      | Eastern hemlock    | 21,610                 |

<sup>EAB</sup> Species is vulnerable because of emerald ash borer, not climate change

More information at: [www.forestadaptation.org/urban](http://www.forestadaptation.org/urban)