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

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.

NIACS Northern Institute of Applied Climate Science

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

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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.

Precipitation will change

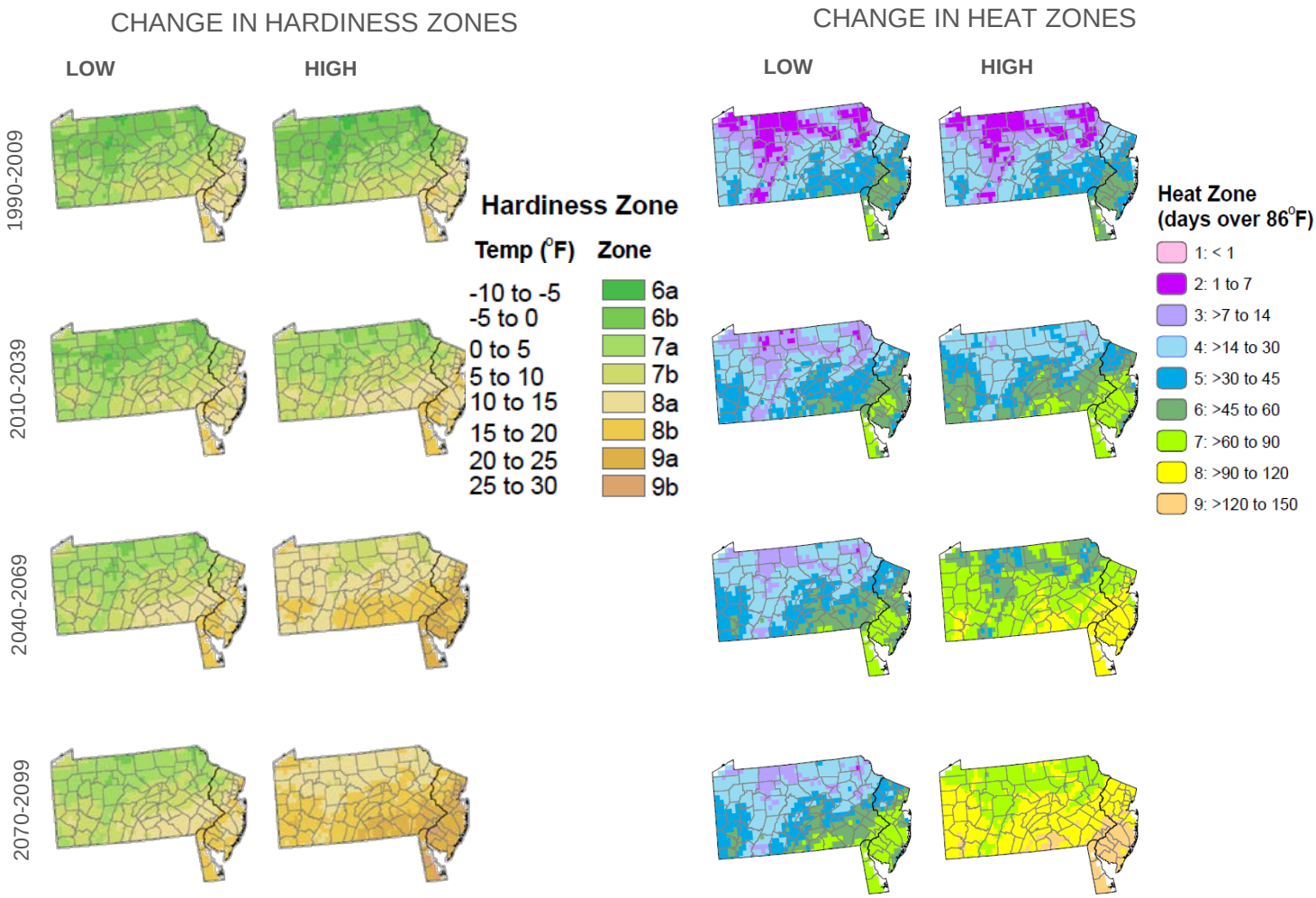
Precipitation is projected to increase in winter and spring and potentially decrease in the summer or fall. Models suggest the frequency of heavy rain events may increase, and more winter precipitation may happen as rain or sleet rather than snow.

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.

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.

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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.[a]

Low Vulnerability:
Adapted to future climate and a range of other stressors

Latin Name	Common Name	Number of Trees[d]
Ailanthus altissima	Tree-of-heaven[i]	183,180
Celtis occidentalis	Hackberry	7,200
Diospyros virginiana	Common persimmon	5,070
Hibiscus syriacus	Rose-of-Sharon	7,200
Ilex opaca	American holly	16,780
Nyssa sylvatica	Blackgum	50,340
Paulownia tomentosa	Princesstree[i]	22,370
Ulmus parviflora	Chinese elm[i]	13,420
Zellkova serrata	Japanese zelkova	7,200

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-Moderate Vulnerability:
Adapted to future climate and most stressors

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

[a]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.

[d]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.

[i] non-native invasive species considered harmful to natural ecosystems

*Estimate is for the *Platanus* genus.

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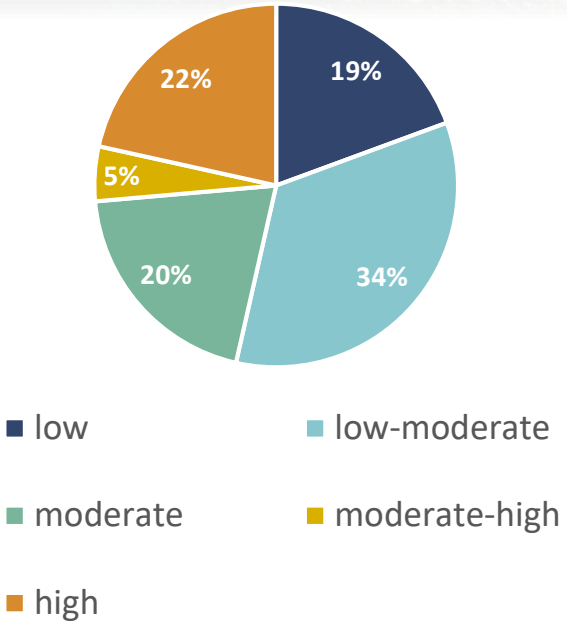
Percent trees in each vulnerability category



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.forestadaptatizon.org**.

Moderate Vulnerability:
May experience some stress from climate change or other stressors

Latin Name	Common Name	Number of Trees
Acer negundo	Boxelder	176,400
Acer platanoides	Norway maple[i]	73,580
Acer saccharinum	Silver maple	5,590
Chamaecyparis thyoides	Atlantic white cedar	21,610
Crataegus viridis	Green hawthorn	5,590
Juglans nigra	Black walnut	57,540
Morus rubra	Red mulberry	5,590
Quercus alba	White oak	20,000
Quercus prinus	Chestnut oak	5,070
Quercus velutina	Black oak	5,590
Salix nigra	Black willow	19,010
Thuja occidentalis	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
Acer palmatum	Japanese maple	21,610
Betula lenta	Sweet birch	5,590
Fagus sylvatica	European beech	7,200
Hamamelis virginiana	American witchhazel	16,780
Liriodendron tulipifera	Tulip tree	27,960
Picea glauca	White spruce	7,200
Platanus x acerifolia	London planetree	42,990*
Robinia pseudoacacia	Black locust	11,190
Sassafras albidum	Sassafras	11,190
Tilia americana	American basswood/ linden	21,610

High Vulnerability:
Will likely experience severe declines from climate or other stressors

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

[EAB] Species is vulnerable because of emerald ash borer, not climate change

More information at: www.forestadaptation.org/urban