Detroit Region

Urban Forest Vulnerability Assessment and Synthesis

SUMMARY AND HIGHLIGHTS

The trees, developed green spaces, and natural areas within the Detroit region's 2.9 million acres of land cover will face direct and indirect impacts from a changing climate over the 21st century. Major threats to the region's urban forest include increased temperature and precipitation, more extreme weather events, pests and diseases, and associated impacts such as flooding, soil erosion, and nutrient runoff.

Urban forests will experience local climate change impacts in the coming decades. A key step to understanding the potential impacts of climate change on the urban forest is to conduct vulnerability assessments.

This assessment evaluates the vulnerability of urban trees and natural and developed landscapes within the Detroit region to a range of future climates. We synthesized and summarized information on the contemporary landscape, provided information on past climate trends, and illustrated a range of projected future climates. Learn more other project activities at:

www.forestadaptation.org/urban

The Climate Has Changed

Since 1960, the Detroit has been warming at a rate of 0.4°F per decade while precipitation has been increasing by about 1 inch per decade. From 1959 to 2011, average overnight temperatures increased by 4.3°F, the number of hot, humid summer days nearly doubled (172%), the number of hot, dry summer days more than tripled (338%) and the number of cool, dry days has been cut nearly in half (70%). Comparing the 1961-1990 average to the 1981-2010 average, the total annual precipitation in southeast Michigan increased by 11%.

The last 2 decades have been the **warmest** on record for Detroit and 7 of the **hottest** 10 years have occurred between 2000 and 2019.

Precipitation in the Detroit region has increased in each season from 1960-2019. The increasing trend is the greatest in the spring (+0.42 inches/decade) and fall (+0.43 inches/decade), and the least in the summer (+0.15 inches/decade).

Source: Pure Michigan

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Global climate models can help us understand how climate may change in the future given changes in greenhouse gas emissions. In this assessment, we report climate projections for two global climate models (IPSL and HAD) under two contrasting greenhouse gas emissions scenarios, RCP 4.5 (low) and RCP 8.5 (high), over the next century compared to the average over the last 30 years of the 20th century.

Temperatures Will Increase

The warming trend is expected to continue, and the extent and intensity will depend on the amount of future greenhouse gas (GHG) emissions. Temperatures are projected to increase across all seasons, GHG scenarios, and models over the rest of the century in the Detroit region compared to the 1980-2009 mean. The increase in mean annual temperature ranges from 5°F to 1°F for the last 30 years of the century compared to the 1980-2009 mean, depending on the GHG scenario and climate model. The summer season has the greatest projected increase, ranging from over 5 °F to over 14°F, and winter and fall seasons have a very similar range. Spring temperature is projected to have the smallest increase, ranging from over 4°F to just over 9°F.

Precipitation Will Change

Annual mean precipitation in the Detroit region is expected to increase 16% on average, which is equivalent to about 5 inches. Precipitation projections vary by season and climate scenario. Generally, precipitation is expected to increase in the winter and spring, decrease in the summer, and remain relatively unchanged in the fall.

CHANGE IN MEAN TEMPERATURE

	Warm-Wet	Warm-Dry	Hot-Wet	Hot-Dry
Winter (Dec – Feb)	15%	31%	42%	29%
Spring (Mar - May)	9%	13%	18%	17%
Summer (Jun - Aug)	7%	12%	19%	16%
Fall (Sep - Nov)	10%	16%	24%	18%

CHANGE IN PRECIPITATION

	Warm-Wet	Warm-Dry	Hot-Wet	Hot-Dry
Winter (Dec – Feb)	↓6%	↑14%	↑36%	↓26%
Spring (Mar - May)	↑15%	↑19%	↑29%	↑17%
Summer (Jun - Aug)	↑4%	↓13%	↓34%	↓25%
Fall (Sep - Nov)	↑3%	0%	↑6%	↑4%

Projected difference in mean daily temperature and total seasonal precipitation at the end of the century (2070 through 2099) compared to 1980 through 2009 for four climate model-emissions scenario combinations (Warm-Wet IPSL 4.5, Warm-Dry HAD 4.5, Hot-Wet HAD 8.5, and Hot-Dry IPSL 8.5)

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The region's urban forest will experience both direct and indirect impacts from a changing climate

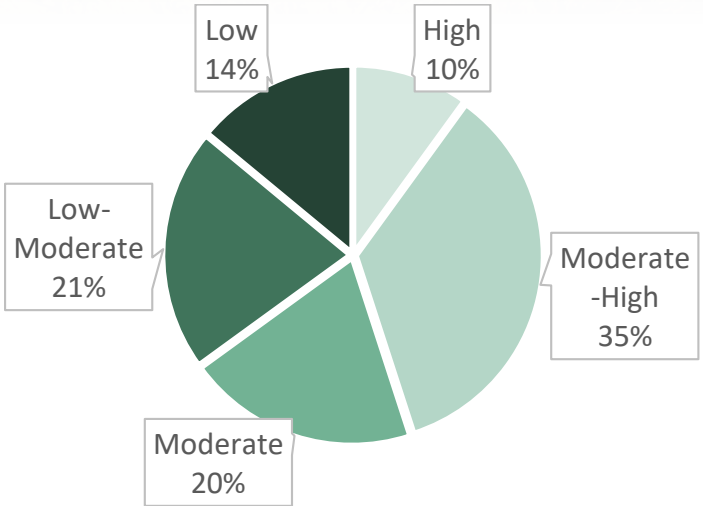
Information from tree species habitat suitability models, hundreds of scientific papers, and local urban forestry professionals' expertise were combined to assess the effects of climate change on the region's urban forest and trees.

Hardiness zones and, more recently, heat zones are used to determine suitability for planting. We used downscaled climate model projections to estimate how heat and hardiness zones may change in the coming decades. Increases in temperature may lead to an increase of 1-2 hardiness zones and 1-4 heat zones.

We used habitat suitability models, projected changes in heat and hardiness zones, and assessments of species adaptability to stressors such as pests, flooding, wind, and temperature extremes to estimate the overall vulnerability of species commonly planted in Detroit. Relative abundance was estimated using the most recent urban forest inventory data for the city.

Species distribution modeling of native species suggests that suitable habitat will decrease for 19 species (31%) and remain stable for eight species (13%). Suitable habitat is expected to increase for eight species (13%), while 16 species (26%) may be able to colonize new, suitable habitats. The rest of the species evaluated had mixed results (17%).

Using heat and hardiness zone shifts for native and non-native species planted in developed sites, most (94%) of the 187 evaluated species are projected to be in a suitable range under a low emissions scenario. Under a high emissions scenario, 42% are projected to be in a suitable range.



Percentage of trees in the region within each vulnerability category under *high* emissions

	Low Emissions				High Emissions			
	1980 to 2010	2010 to 2039	2040 to 2069	2070 to 2099	1980 to 2010	2010 to 2039	2040 to 2069	2070 to 2099
Hardiness Zone	6	7	7	7	6	7	8	8
Heat Zone	5	6	7	7	5	7	8	9

Common Species with Low–Moderate Vulnerability	Common Species with Moderate-High Vulnerability	New or Rare Species with Low Vulnerability
American Elm	American Linden	Common Persimmon
American Sycamore	Boxelder	Downy Serviceberry
Common Hackberry	Callery Pear[i]	Fringetree
Green Ash*	Common Horse Chestnut	Kentucky Coffeetree
Northern Red Oak	Northern Catalpa	Mockernut Hickory
Red Maple	Pin Oak	Osage-Orange
Ginkgo	Silver Maple	Sourwood
Honeylocust (thornless)	Sugar Maple	Sugarberry
London Planetree	Winged Elm	Umbrella Magnolia
Siberian Elm[i]	White Mulberry[i]	Water Locust

[i] invasive species, *vulnerable to emerald ash borer (EAB)

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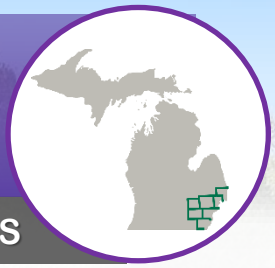

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Local Considerations

Climate change will not affect all places in the landscape in the same way. Some neighborhoods or ecological communities may be more vulnerable than others if they lack biodiversity, are in areas susceptible to climate change impacts, or lack the resources to adapt.

Vulnerability is the susceptibility of a system to the adverse effects of climate change. It is a function of potential climate change impacts and the adaptive capacity of the system. A system is vulnerable if it is at risk for no longer being recognizable as that community type, or if the system is anticipated to suffer substantial declines in health or productivity.

A four-day workshop was held to learn about the current and anticipated effects of climate change on Detroit's developed and natural areas and to understand concepts of vulnerability and adaptation and how to apply these concepts to real-world urban forestry adaptation projects. Outcomes of this workshop included six climate adaptation projects in the Detroit region.

This process can be used by communities to help identify potential adaptation strategies. Visit www.adaptationworkbook.org to explore how climate change may affect your region and forested ecosystems and to access adaptation "menus" that provide curated lists of adaptation actions by topic.

What can managers do?

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.

Climate change impacts will vary across the landscape. Examples of characteristics that make systems more adaptable include high species diversity, landscape connectivity, and the ability to bounce back following a disturbance, such as a drought, flood, or fire. Managers can use scientific information from the assessment and other sources to better understand which places may be most vulnerable.

Resources are available to help forest managers and planners incorporate climate change considerations into forest management. To learn more about the vulnerability of urban forests, visit www.forestadaptation.org/assess/ecosystem-vulnerability/urban.

The Climate and Health Action Guide and Menu is designed to help urban forest managers and allied professionals promote human health and climate benefits of urban forests while minimizing climate change risks. Visit www.vibrantcitieslab.com/guides/climate-health-action-guide to take action.

More Information

www.forestadaptation.org/urban

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