City of Austin
Urban Forest Vulnerability Assessment and Synthesis

The trees, developed green spaces, and natural areas within the City of Austin's 400,882 acres will face direct and indirect impacts from a changing climate over the 21st century. Major current threats to the region's urban forest include invasive species, pests and disease, and development.

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 City of Austin 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 record-keeping began in 1938, maximum temperatures have been increasing at a rate of 0.4°F per decade with mean and minimum temperatures increasing at a rate of 0.3°F per decade. Since 2000, all years have been above the 1961-1990 average – a standard baseline for examining climate trends. Although it is unclear how climate change is affecting the incidence of heat waves, 8 of the top 10 years with the most 100°F days were in the 21st century.

It is highly likely both heavy rain events and severe droughts will increase and, overall, the balance of precipitation and temperature may shift Austin's climate towards that of the arid Southwest.

Six of the ten hottest years in Austin have occurred between 2000 and 2019.

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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 under two contrasting greenhouse gas emissions scenarios (high and low) over the next century compared to the average over the last 30 years of the 20th century.

Temperatures will increase

All global climate models project that temperatures will increase in Austin. Model projections suggest an increase in temperature over the next century across all seasons by 5 to 10 °F. Growing seasons will continue to lengthen due to warmer temperatures.

Evidence suggests that winter minimum temperatures will increase by 5 °F and summer maximum temperatures by 3 °F even in the low emission scenario.

Precipitation will change

Decreases in precipitation are likely, according to different climate models, but the impacts vary by season and scenario. With low emissions, overall annual precipitation is projected to marginally decrease by 2100, but the effects are primarily expected during summer, winter, and fall, while spring precipitation is expected to increase. Under high emissions the model projects much greater variability with the potential for significantly reduced summer precipitation.

CHANGE IN MEAN TEMPERATURE

	LOW emissions	HIGH emissions
Winter (Dec – Feb)	8%	17%
Spring (Mar - May)	4%	15%
Summer (Jun - Aug)	2%	12%
Fall (Sep - Nov)	4%	16%

CHANGE IN PRECIPITATION

	LOW emissions	HIGH emissions
Winter (Dec – Feb)	↓6%	↑14%
Spring (Mar - May)	↑6%	↑9%
Summer (Jun - Aug)	↓4%	↓35%
Fall (Sep - Nov)	↓6%	↑5%

Projected difference in mean daily temperature and total seasonal precipitation at the end of the century (2070 through 2099) compared to 1981 through 2010 for two climate model-emissions scenario combinations.

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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 hardiness zone and 2-3 heat zones.

There are native species like Texas Mountain Laurel and Texas Persimmon which are thriving now and can tolerate both drought and warmer hardiness zones. There are also new and/or rare species that can be considered for their low vulnerability and likely success in modeled future conditions.

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 Austin. Relative abundance was estimated using the most recent urban Forest Inventory and Analysis data for the city.

Overall, nearly 90% of all species in the region are moderately to highly vulnerable but, more than 75% of the low and low-moderate vulnerability species are native to the Austin area.
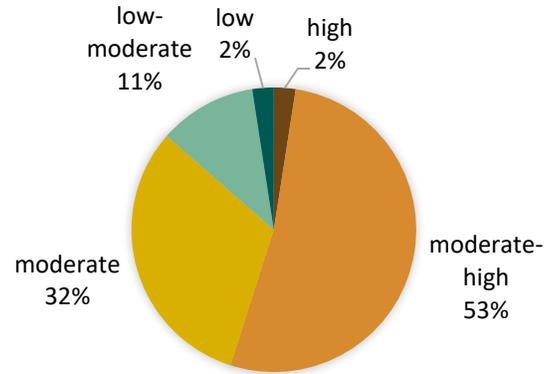
Percentage of trees in the region within each vulnerability category

- low-moderate 11%
- low 2%
- high 2%
- moderate-high 53%
- moderate 32%

	Low emissions				High emissions			
	1981 to 2010	2010 to 2039	2040 to 2069	2070 to 2099	1981 to 2010	2010 to 2039	2040 to 2069	2070 to 2099
Hardiness zone	8b	8b	9a	9a	8b	8b	9a	9b
Heat zone	9	10	11	11	9	10	11	12

Common Species with Low Vulnerability	Common Species with High Vulnerability	New or Rare Species with Low Vulnerability
Chinaberry[i]	American Sycamore	Arroyo Sweetwood
Honey Mesquite	Ashe Juniper	Brazilian Bluewood
Japanese Privet	Black Walnut	Catclaw
Jerusalem Thorn	Eastern Cottonwood	Catclaw Mimosa
Mexican Ash	Green Ash	Eve's Necklace
Mexican White Oak	Pecan	Mexican Buckeye
Paper Mulberry[i]	Post Oak	Mexican and Texas Redbud
Prairie Sumac	Sugarberry	Mexican Sycamore
Texas Madrone	Texas Red Oak	Texas Hercules' Club
Texas Mountain Laurel	White Shin Oak	Texas Kidneywood

[i] invasive species

Vulnerability Case Studies

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.

To assess vulnerability, we assembled a panel of experts on the ecology and management of Austin's urban forest, including developed and natural areas, for a two-day workshop. The areas in the Austin region tended to be rated in the moderate vulnerability range, indicating that there wasn't one specific area type that was more vulnerable than others. However, the underlying factors that contributed to their vulnerability varied greatly.

This process can be used by communities to help identify potential areas were they may wish to develop adaptation strategies.

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. A set of Forest Adaptation Resources is available at www.forestadaptation.org.

More information

www.forestadaptation.org/urban

Citation: Brandt, L.A.; Rottler, C.; Gordon, W.S., Clark, S.L; O'Donnell, L.; Rose, A.; Rutledge, A. King, E. 2020. Vulnerability of Austin's urban forest and natural areas: A report from the Urban Forestry Climate Change Response Framework. Report NFCH-5. Houghton, MI: U.S. Department of Agriculture, Climate Hubs. 82 p.

The Climate Change Response Framework is a core forest adaptation effort of the USDA Northern Forests Climate Hub