TREE CITY USA®
BULLETIN
No. 92
Editor: Dr. James R. Fazio • $3.00

Urban Trees and Climate Change

It has been said that the only constant in life is change. It is almost certain that our nation's climate is one of those changes. Regardless of what is driving the change, increased heat in urban areas is affecting trees and cannot be ignored.

Increasing temperatures, especially in already high urban heat islands, put added stress on trees. Planning ahead to develop adaptive policies and practices may be necessary in order to keep urban forests healthy.

"Climate change is poised to upend almost every part of the way we do things, from our lifestyles to what our states grow," read one editorial in a western newspaper. The writer went on to opine that predictions by scientists are becoming more accurate and that "we must heed their warnings." Half tongue-in-cheek, the newspaper suggested that California's prized almond trees might eventually do better in the state of Washington and that Washington's apples just might move northward to Canada.

As can be seen on pages 2 and 3 of this bulletin, there is considerable evidence that change is in the air. That change currently seems to be going in only one direction and it is not good. According to a report by the United Nations Environment Program and the World Meteorological Organization, global climate change is projected to increase the world's average surface air temperature by 1.8 F to 6.3 F by the year 2100. Although this may seem like a small change, urban heat islands and other city conditions exacerbate this effect. Scientific literature points out that urban areas typically have warmer air temperatures, lower humidity, and more precipitation than rural environs. And, on a larger scale, climate change is believed to already be responsible for the increased frequency and duration of extreme events such as heavy rains — and the opposite, droughts — and a decrease in available soil moisture for plants during summer months.

Trees are already being affected by heat stress in many parts of the country. It is a subject that deserves the attention of tree boards and policy makers. As can be seen in the following pages, there are ways to combat the changes, and some communities and organizations are stepping forward to lead through planning and action.

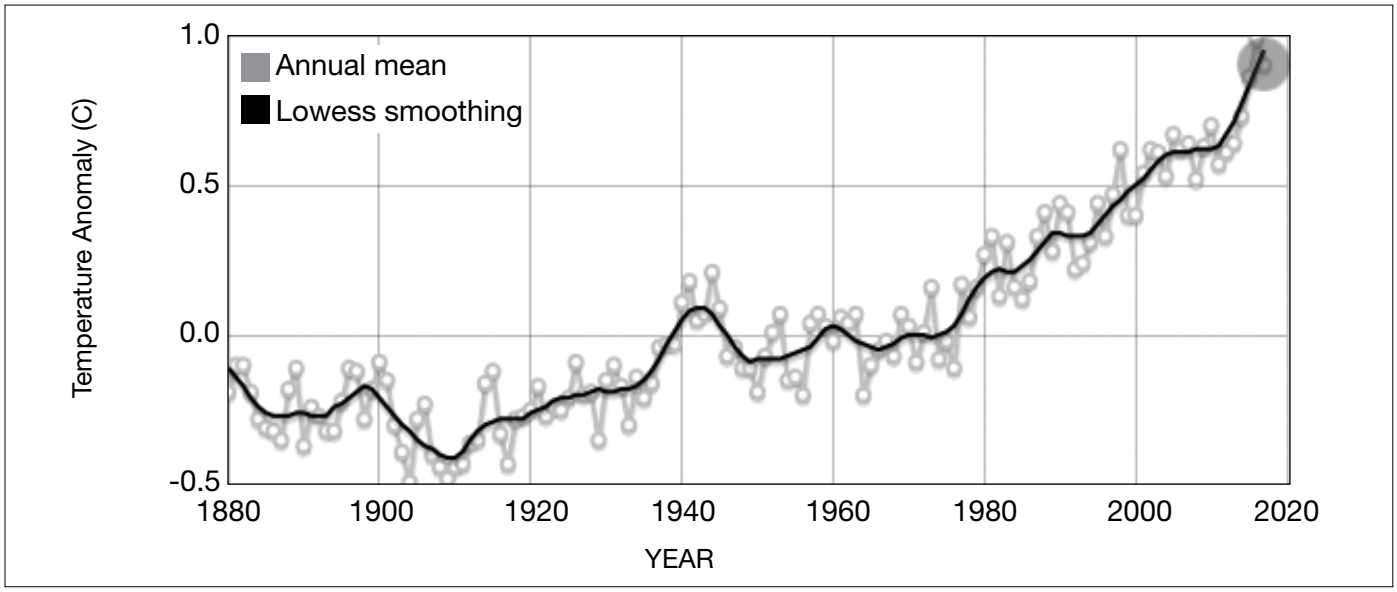
Arbor Day Foundation®
100 Arbor Avenue • Nebraska City, NE 68410

Evidence of Change — and Impacts Not to be Ignored

Few things in recent years have engaged scientists in public debate as has climate change. The cause(s) of our warming planet are particularly contentious and politically sensitive, but there is little doubt about Earth's rising temperature and its impacts.

- Arctic temperatures are continuing to rise while sea ice declines. The U.S. National Oceanic and Atmospheric Administration states that warming temperatures are higher than at any other time in at least the past 1,500 years.
- Permafrost is thawing, threatening northern roads, buildings, and ecological balance in the tundra and northern boreal forests.
- According to the Associated Press, rising sea levels are killing trees along vast swaths of the North American coast by inundating them in salt water.
- Rising sea levels increase the risk of coastal flooding, especially during storm surges.
- The intensity of hurricanes has been increasing since the 1970s, causing immense damage.
- Dangerously hot weather is occurring more frequently than it did 60 years ago.
- Mountain snow melts earlier and vegetation dries earlier, adding to the risk of wildfires.
- Wildfires are increasing, and the wildfire season is getting longer, especially in the West and South.
- Human health risks are rising due to summer heat, increased air pollution, and a longer, more intense allergy season.
- Heavier precipitation and flooding can be expected.
- Bark beetle infestations are causing widespread forest destruction due to milder winters.
- Droughts have become more severe in some areas of the country.
- Soil moisture is reduced, and pressure on groundwater supplies is increasing.
- Seasonal changes are being experienced with spring-like weather arriving 10 days earlier on average in the northern hemisphere. This leads to soils drying earlier and to greater danger of frost damage to trees.
- Habitat is shrinking for plants and animals that are dependent on cooler environments.

SOURCES: Primarily the U.S. National Oceanic and Atmospheric Administration and the Union of Concerned Scientists. For links, visit arborday.org/bulletins.



A graphic illustration prepared by NASA's Goddard Institute for Space Studies showing the change in global surface temperature relative to 1951-1980 average temperatures.

Forest fires are becoming megafires as drought dries large parts of our land. In some areas, wildfire season has lengthened by nearly 80 days in the past 30 years.

Rising sea levels, especially when combined with hurricanes and sea surges, destroy property and saturate the soil with tree-killing salt.

Warming ocean temperatures may be the cause of more frequent and intense storms inland.

Trees and Heat Stress

Heat stroke in humans is a well-known danger. In this case, the body is unable to sufficiently dissipate excess heat and the body temperature rises to a point that can lead to death unless fast action is taken. Heat stress in trees is more subtle but can be deadly, although the damage may occur over a period of years.

WHAT IS HEAT STRESS?

Dr. Kim Coder of the University of Georgia explains that 70 F to 85 F is the optimal range of temperatures for tree growth. Depending on several variables, 115 F can signal the onset of thermal death. A key result of high temperatures is that stomata in leaves close, reducing transpiration (water loss). This not only shuts down photosynthesis, it reduces the tree's most efficient method of cooling and, importantly, interrupts the essential process of pulling nutrients and water up from the soil. Leaves tend to wilt under these conditions and, unseen within the tree, cambial and phloem in the twigs and trunk also suffer. Impervious surfaces around a tree — or even turf — make the heating and drying even worse. A number of other physical constraints and metabolic dysfunctions also occur, and none of them are good for the tree. For links to a more in-depth discussion, visit the Supplemental Resources Library mentioned on page 8.

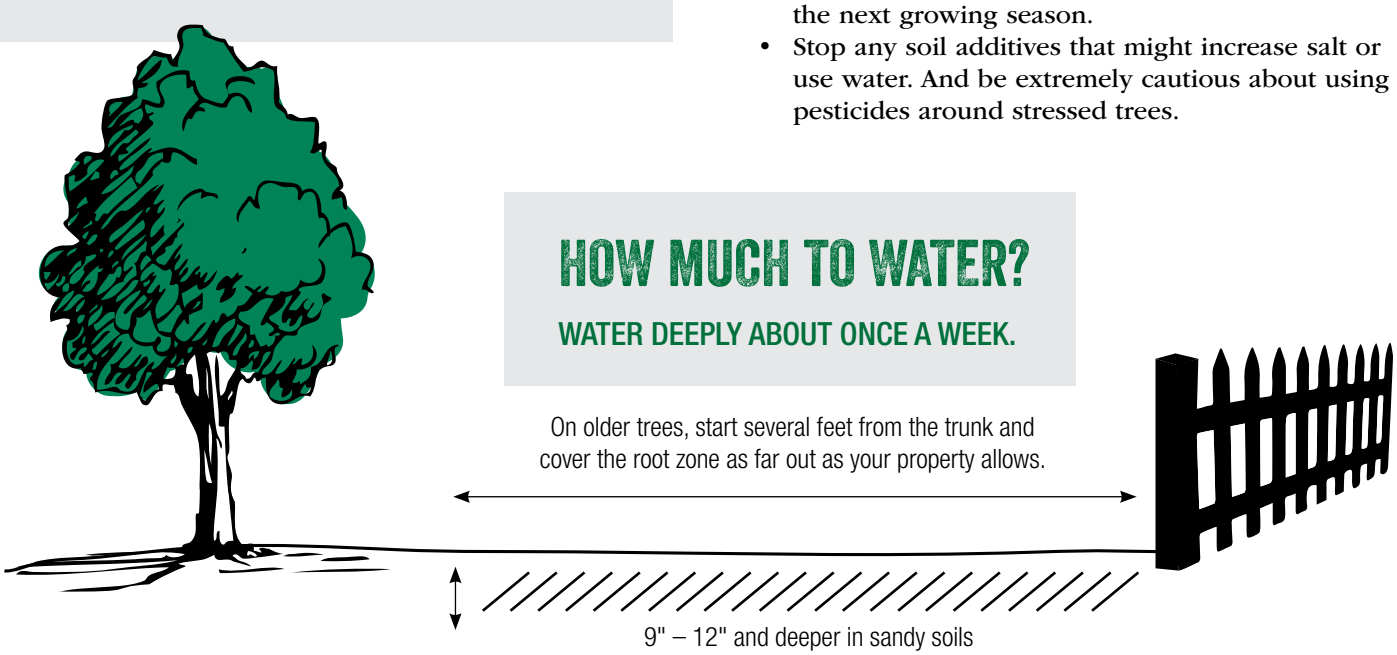
TOO LITTLE WATER OR TOO MUCH?

Ironically, leaf symptoms are similar in trees suffering from drought and those drowning from too much water. Either problem can cause root death with the result being that not enough water can move upward to the leaves, which then become scorched-looking.

RECOMMENDED TREATMENTS

Relief from heat stress is essential to ensure tree health during extreme heat. Here are some suggestions adopted from the work of Dr. Coder:

- Water, sprinkle, and mist for improved water supply, reduction of tissue temperature, and lessening of the water vapor pressure deficit that leads to the closing of stomata.
- Partially shade the tree (e.g., 10–20 percent of full sunlight) but without blocking out sunlight needed for photosynthesis.
- Reduce reflections and mute radiative heat by using site colorants (light colors and white) and surface treatments (low-density, evaporative surfaces) on nearby hardscapes. Pervious, evaporative pavements and low-density, non-heat-absorbing surfaces can help minimize or dissipate heat loads.
- Mulch in moderation. The best mulches are low-density, coarse-textured, natural organic materials. Their function is to minimize soil-evaporative water loss while not disrupting soil gas exchange processes (i.e., oxygen into soil and carbon dioxide out of soil). Thin mulch layers, reapplied often, work best.
- Don't fertilize. During extreme heat load periods, some tree and site treatments can be damaging and should be delayed until full leaf expansion the next growing season.
- Stop any soil additives that might increase salt or use water. And be extremely cautious about using pesticides around stressed trees.



HEAT-TOLERANT TREES

AMERICAN PLUM
ACACIA
BUCKEYE
CATALPA
CEDAR
CRAPEMYRTLE
HACKBERRY
HAWTHORN
HONEYLOCUST
HYBRID POPLAR
JUNIPER
SOME OAKS
SOME PINES
SILVER LINDEN

Scientists are hard at work trying to develop "thermotolerance" in trees using molecular and biotechnological tools. Promising work at the Universidad Politécnica de Madrid in Spain has produced poplars that are significantly more tolerant to high temperatures than control trees in their experiments. The research has focused mostly on poplars grown in plantations, but scientists are looking at trees such as chestnuts that apparently contain a natural chemical that make it a good candidate for improving heat stress adaptation. It will help the researchers better understand the biochemistry involved in heat tolerance. Eventually perhaps city shade trees will benefit from the research. But this work is slow and difficult, so in the meantime, consider planting trees that are relatively heat-tolerant. Species and cultivars will vary regionally, but at left are some of the more common ones.

THE AMERICAN HORTICULTURAL SOCIETY HEAT MAP

To help tree planters consider not only what trees can withstand the average number of coldest days of winter, the American Horticultural Society has developed a similar map to warn about the hottest weather. It is divided into 12 zones based on the average number of days each year that a given region experiences "heat days," that is, those with temperatures higher than 86 degrees. For more information, you can visit ahsgardening.org and search for "plant heat zone map."

Species like hackberry that grow naturally in hot, dry climates should be considered for future planting in more urban areas.

The Response

How individuals, communities, and government agencies are responding to climate change varies widely. Researchers at the University of Arizona conducted a study of professionals in academia and forestry and found a correlation between perceptions about climate change and their willingness to consider adaptive or mitigation measures. Caution and the need for more research is clearly needed, but action is also being slowed due to the high level of political interest in the subject of climate change. Nonetheless, there is considerable activity in trying to prepare for or even stem increasing temperatures.

TWO FORMS OF ACTION

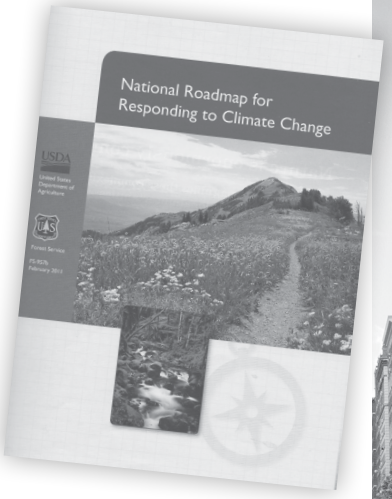
ADAPTATION: Efforts to reduce the effects or vulnerability to climate change.

- Monitoring and planning
- Assessing risks and vulnerability
- Ensuring biodiversity
- Planting with an eye to future conditions

MITIGATION: Interventions to reduce emissions or enhance storage of greenhouse gases.

- Promoting uptake and storage of atmospheric carbon (tree planting, wood products, recycling, etc.)
- Making high-level decisions/agreements to reduce fossil fuel emissions and encourage cleaner renewable energy sources.
- Reducing greenhouse gas emissions by creating pedestrian-friendly communities, energy-saving equipment, etc.

FEDERAL RESPONSE



As early as 2011, the U.S. Forest Service responded to the change of climate by publishing the *National Roadmap for Responding to Climate Change*. This, in turn, was a response to a goal in the 2010-2015 *Strategic Plan* to "ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources." This document can be found under Available Bulletins and Resources for this edition at **arborday.org/bulletins.**

The Department of Interior has also responded in an effort to "work with natural and cultural resource managers to gather the scientific information and build the tools needed to help fish, wildlife, and ecosystems adapt to the impacts of climate change." A major approach to this has been the creation of eight Climate Science Centers to address regional impacts of climate change intended for "offering support and research." Each center is hosted at a major university.

The National Oceanic and Atmospheric Administration is another leader in the effort to understand and cope with climate change. This agency's Climate Program Office includes a grant program and an opportunity for a variety of partnerships.

Communities need to examine the vulnerability of their trees to current and future climate conditions and develop specific adaptation plans.

URBAN STRATEGIES

Various communities are taking a proactive approach to our changing climate. One of the first to do so was King County in the state of Washington. Working with the University of Washington, a *King County Climate Plan* was developed "based on the conviction that climate change is both a problem and an opportunity for communities to improve environmental quality through mitigation of greenhouse gases and simultaneously build resilience to adapt to global climate change." For even broader impact, King County and partner organizations created the publication (available online) *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments.*

THE CHICAGO EXAMPLE

Assessing the vulnerability of the urban forest to climate change is an important first step toward action that will prevent tree loss through drought and pests. A team led by the U.S. Forest Service's Northern Institute of Applied Climate Science used heat and hardiness zones to analyze the vulnerability of the city's tree species and cultivars to rising temperatures. It also produced an *Adaptation Workbook* that is applicable to urban forests in other areas of temperate North America. Some of the recommended actions to address climate change are:

- Resisting change through management practices such as watering during drought periods and installing gray or green infrastructure to control flooding.
- Building resilience through enhanced age, species, and genetic diversity in the urban forest.
- Incorporating new species not currently found in the area.

The Philadelphia Parks & Recreation Department is looking to the future by experimenting with four southern tree species (yellowwood, Carolina silverbell, loblolly pine, and southern red oak) and numerous shrubs. Twelve of each species were planted in research plots and protected with deer exclosures. Annual measurements on each plant are taken to assess survival, condition, caliper (trees), crown spread (shrubs), and height. After 10 years or more, the results are expected to help determine adaptive management approaches for Philadelphia's urban forest.

Growth Award

Tree City USA® communities that create a policy or demonstrate a new technique to assess or adapt to climate change — including control of invasive species — may qualify for points toward the Tree City USA Growth Award.

TREE CITY USA®

Mitigating the Heat

Much of the climate change attention in urban forestry is on understanding this phenomenon and finding ways to adapt to warmer temperatures. However, mitigation is also important. Here are a few actions that can be taken by individuals and organizations, as suggested by Dr. David Nowak of the U.S. Forest Service Northern Research Station.

- ☑ Plant trees — and sustain large, healthy trees.
- ☑ Select low VOC-emitting trees and trees with potentially long lives.
- ☑ Plant in locations that conserve energy.
- ☑ Avoid pollutant-sensitive species, and plant in polluted and/or heavily populated areas.
- ☑ Plant trees to shade parked cars.
- ☑ Supply ample water when needed.
- ☑ Plant evergreens when possible.
- ☑ Use low-maintenance trees and reduce fossil fuel use during maintenance.
- ☑ Utilize wood for products.
- ☑ Use tree wastes as a source of renewable energy production.

FOR MORE INFORMATION

Links to more suggestions for mitigation and the reasons behind each can be found, along with a wealth of other information about climate change, by visiting **arborday.org/bulletins.**

PHOTOS COURTESY OF: Philadelphia Parks & Recreation (page 6)

 Published by the Arbor Day Foundation; James R. Fazio, editor; Kerry Wilken, graphic designer. Technical reviewer for this issue: Dr. David Novak, U.S. Forest Service, Syracuse, New York.

Tree City USA Bulletin ORDER FORM

Name _____

Organization _____

Address _____

City _____ State _____ Zip _____

Phone _____

Most issues of Tree City USA Bulletin reflect the kind of positive effects experienced by residents and businesses thanks to continuous, systematic urban forestry. Here are some that may be of special interest. For a complete list of bulletins and bulk quantities/pricing, visit **arborday.org/bulletins.**

		1 Issue $3.00 ea.
4. The Right Tree for the Right Place	4.	$
7. How to Save Trees During Construction	7.	
14. How to Kill a Tree	14.	
16. How to Recycle Shade Tree Materials	16.	
17. How to Landscape to Save Water	17.	
19. How to Select and Plant a Tree	19.	
20. A Systematic Approach to Building With Trees	20.	
21. How Trees Can Save Energy	21.	
24. Trees and Parking Lots	24.	
26. Understanding Landscape Cultivars	26.	
27. How to Manage Community Natural Areas	27.	
31. Tree Protection Ordinances	31.	
35. Protect Trees During Underground Work	35.	
39. Putting Trees to Work	39.	
45. Trees for Better Streets	45.	
46. Data to Advocacy	46.	
52. Make Good Use of Small Spaces	52.	
55. How Trees Can Retain Stormwater Runoff	55.	
56. Help Stop Insect & Disease Invasions	56.	
57. Trees and Public Health	57.	
59. Permaculture and the City	59.	
61. Trees & Green Space Make Economic Sense	61.	
62. Help Fight Invasive Trees	62.	
64. Saving Our Heritage Trees	64.	
69. Make Room for Trees	69.	
71. The Healing Power of Trees	71.	
73. How to Start an Urban Orchard	73.	
75. How to Make Trees Storm Resistant	75.	
76. How to Fight the Emerald Ash Borer	76.	
77. How to Grow a Better City Tree	77.	
81. Urban Wood: A Wonderful Resource	81.	
82. Trees and Water	82.	
84. Understanding Tree Canopy Assessments	84.	
87. Making a Case for Community Trees	87.	
89. How to Measure Progress	89.	
91. How to Start Trees Off Right	91.	
---- Tree City USA Annual Report		
TOTALS:	$	

Tree City USA Bulletin 3-Ring Binder ..... $7.95 $ _____

Complete Bulletin Set with binders ..... $109.95 $ _____

TOTAL PAYMENT: ..... $ _____

Order Tree City USA Bulletins online at **arborday.org** or send this form and mail with your payment to:

Arbor Day Foundation • 211 N. 12th Street • Lincoln, NE 68508
888-448-7337 • *(Make checks payable to Arbor Day Foundation)*

1925 101

Published for the ***Friends of Tree City USA*** by **Arbor Day Foundation®**
100 Arbor Avenue • Nebraska City, NE 68410
arborday.org
RECYCLED PAPER RECYCLABLE | PRINTED WITH SOY INK
50110201