ROUNDTABLE

Climate Change Impacts on Urban Forestry

This roundtable asks, "How has your regional weather been trending over the last five to ten years, and how has this affected the tree species you select and the way you manage your urban forest?" Also, there is an entry that looks at the northern movement of mangrove swamps in Florida, and another that reviews the possible effects of climate change on urban trees in New England.

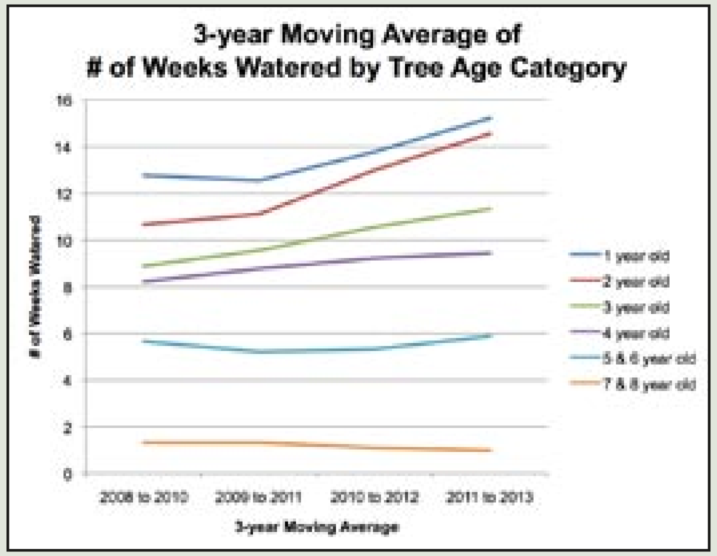
The City of Surrey, British Columbia is situated in the temperate rainforest of the Pacific Northwest coast. Surrey's climate is generally characterized by warm, wet winters (October to May) with average high temperatures of 10.5°C or 51°F and relatively hot, dry summers (June to September) with average high temperatures of 21°C or 70°F. Annual average precipitation in Surrey is 1,050 mm or 41 inches. While this sounds like a significant amount of moisture, 84% of this precipitation falls between October and May. Between the months of June and September, on average, Surrey receives just 170 mm or 6.7 inches of rain.

As the above indicates, trees planted in Surrey need to thrive in warm, wet winters and hot, dry summers. Some species that were often planted in the past such as *Malus* 'Floribunda' and 'Rudolph', *Pyrus calleryana* 'Chanticleer', and *Syringa reticulata* 'Ivory Silk' have suffered from these conditions and have been subject to large-scale removal and replacement projects. In recent years, despite noted increases in the intensity and length of the summer drought period, tree species that have proven to perform well in Surrey include *Sequoiadendron giganteum*, *Quercus coccinea*, *Pinus nigra* 'Select Green', *Acer* x *freemanii*, and *Carpinus betulus*.

Surrey currently plants approximately 5,000 new shade trees every year along its streets and in its parks. In order to maximize survival of this significant green infrastructure investment, a comprehensive watering program is carried out. In 2014, approximately 24,000 trees received supplemental watering, depending on the severity of drought conditions.

The number of weeks watered and the ages of trees watered are strong indicators of the severity of drought experienced in Surrey over the last number of years. The "3-Year Moving Average" chart illustrates the trend of the increasing number of weeks watered between 2008 and 2013. For all age categories (except 7- & 8-year-old trees), the number of weeks watered, on a 3-year moving average basis, has increased.

Armstrong maples (*Acer* x *freemanii*) have endured drought well in Surrey, BC. Photo Courtesy City of Surrey, Urban Forestry and Environmental Programs



This trend is particularly evident for 1-, 2-, and 3-year-old trees. Surrey watered 1-year-old trees nearly 2.5 weeks longer, on average, for the period of 2011 to 2013 compared to the period 2008 to 2010. Surrey watered 2-year-old trees nearly 4 weeks longer, on average, for the period of 2011 to 2013 compared to the period 2008 to 2010. Surrey watered 3-year-old trees nearly 2.5 weeks longer, on average, for the period of 2011 to 2013 compared to the period 2008 to 2010.

It is no secret that the City of Surrey receives plenty of rain through two-thirds of the year. And anecdotal information and the gut-feel of urban forestry professionals tell us that summers seem to be getting hotter and drier. The data in the "3-Year Moving Average" chart provides some quantitative illustration that corroborates the subjective sense of climate change in the region towards longer and more intense drought.

As Surrey continues its robust planting program into the future, its urban foresters will need to regularly evaluate existing species and also take a close look at species that thrive just a little further south or a little further inland in order to develop an urban forest that is capable of thriving in a changing climate. Just like the trees that thrive in the City, if you can handle the moisture for eight months and you enjoy a dry spell every summer, Surrey might be the place for you.

—Neal Aven, Urban Forestry & Environmental Programs Manager, City of Surrey, Parks Division

The City of Surrey, British Columbia is experiencing longer, more intense droughts and is enlisting watering help from citizens. Photo Courtesy City of Surrey, Urban Forestry and Environmental Programs

The weather in Ohio is highly variable, and I can't claim to see any predictable trends developing. However, the numbers prove that our overall climate is changing and warming, and phenological indicators in our region tell us that our growing seasons are lengthening. Just how our changing climate affects local weather remains to be seen, and that's the trick for urban foresters, farmers, and others who deal with plant cultivation.

Will we experience a gradual, general warming? How will this change precipitation patterns? Will changes be consistent over large areas, or will different communities or neighborhoods have differing experiences due to the complex factors that influence local weather?

Or, will global atmospheric changes instead lead to more weather extremes? We all know extreme weather (wind, rain, snow, ice, heat, or cold) is bad news for city foresters! It has been decades since I've been able to enjoy a good storm. We were hit hard by Hurricane Ike in 2008 (yes, a hurricane in Ohio) and I'd never heard of a derecho until we were clobbered during the summer of 2012. Violent weather is inevitable, but is it increasing in frequency or intensity?

In a sense, many farmers have a big advantage over urban foresters. They plant crops of annual corn, beans, or wheat, and are thus able to select different crops and cultivars based on recent experience. City foresters, on the other hand, plant a crop with a rotation of 20 to 100 years. I have not heard anyone of sound mind predicting what growing conditions we will be living with in the year 2114.

In Upper Arlington, Ohio we have had serious droughts on occasion and years of abundant rainfall (including 2014). The thermometer routinely hits the upper 90s F (32-27 C) in summer, and winter temperatures can dip to -20 F (-29 C). Most recently, it's the cold that has caught me off guard. A few nights of -20 were not unheard of 30 years ago, but I was on the cusp of believing that we had moved from USDA Zone 5 to Zone 6 in the last 20 years.

The winter of 2013/14 alleviated me of that notion when a polar vortex hammered the central US for an extended period. Species that we planted to thrive in a gradually warming Zone 6 did not fare well. Particularly hard hit for us were *Magnolia grandiflora, Acer platanoides, Albizia julibrissin, Lagerstroemia indica, Quercus phellos,* and *Prunus*. Amazingly, local garden centers were again selling these species to hopeless optimists (or the uninformed) just months after they were wiped out by the deep freeze.

The polar blast was also a great reminder of the importance of provenance. Within some species, the cold damage to individual trees ranged from zero to complete death of tissues above the snow line. This was particularly noticeable in our *Koelreuteria paniculata* and *Liquidambar styraciflua*.

Ultimately, I think the best strategy is biodiversity. We preach diversification in our community forests for many reasons, and it is wise to include species, genotypes, or cultivars that may be on the edge of their range for cold, heat, or water needs as a hedge against future climate change. However, these experiments should be limited in scope until long term trends are more apparent, and species with a broad set of environmental tolerances may be preferable to those with narrow tolerances.

Finally, beware those who claim to know what the future holds. I won't be around in 50 years to prove them wrong, but I expect that many of the trees I plant will be here and going strong.

—Steve Cothrel, Superintendent of Parks and Forestry, Upper Arlington, Ohio

Weather is local, climate is global. Weather can't be *reliably* measured and predicted beyond days (or hours), while climate can be measured and predicted to some extent through centuries or millennia. Either way, those predictions depend upon a lot of models and proxy data to fill in the blanks.

Did anyone really believe the new zone map that came out a few years ago, showing the northward shifting of hardiness zones? If you did, you paid for it during the Polar Vortex collapse of 2014. What we have here is not a steady trend toward the bland benign—it's the gateway to horticultural hell. Planting trees, selecting trees, designing with and caring for trees all must be done in a way that factors in the unexpected.

My own approach is, first and foremost, to avoid formal, geometric designs and monotypic plantings. Diversity is king. This might seem obvious to urban foresters, but so many people who call themselves designers still follow the approach of André Le Nôtre in trying to assert dominance over nature. King Louis XIV could get away with that at Versailles because he could afford to have massive crews of servants replace full-sized dead trees with full-sized live trees. But it wasn't a good idea for the average Joe back then, and it still isn't now.

Allées, in particular, can be made with informal, diverse, and seemingly random trees instead of measured rows of identical trees. It's not the trees that matter as much as it is the visual voids between the trees. Look at the Nebraska home of J. Sterling Morton, the founder of Arbor Day. The approach is a magnificent allée of majestic trees that frame the view of the mansion with a variety of colors and textures. No two of them are alike or in a straight line, and as some of them inevitably slip away, the visual effect is not lost.

Size matters, and the smaller, the better. Try to use small trees that can grow into and adapt to your site, rather than large specimens that can never be happy there (or will die trying). Use the modern techniques of tree tubes, structural soils, and root training to give your trees a head start. Consider pH, drainage, mycorrhizae, and general soil biology with just as much sincerity as your engineer considers compaction. Prune properly, both above and below ground.

Invasiveness is becoming more and more important. The days are gone when we could plant species such as Callery pear with impunity. Actually, those days were never here, but it's time we gave more attention to the reasons why. 'Bradford' pear and its Callery cohorts are becoming some of the most notorious thugs in eastern North America, displacing many native species and the host of life attendant to them. Any nursery that still sells these weeds to the gullible public crosses the line into the Dark Side of irresponsibility, and any landscape architect who still specifies them should restrict his/her practice to irrigation or golf.

Find a good mix of trees that give you diversity in wildlife habitat, color, seasonality, and survivability under stressful conditions. Use the 10-20-30 rule: Have no more that 10% of your trees from any one species; 20% from any one genus; and 30% from any one family. Some of them won't make it in the long term as our climate continues to run wild, but by the luck of the draw and with some common sense, many of them will. Emphasize species that have shown resilience in nature under a variety of conditions and/or under your own specific extreme conditions. Many oaks are tough under a variety of circumstances; beech, maybe not so much.

—Guy Sternberg, Landscape Architect, Certified Arborist, and Founder and Manager, Starhill Forest Arboretum of Illinois College

Drought-decimated arborvitaes (*Thuja occidentalis*) • Photo by Guy Sternberg

My perceptions of regional five- to ten-year weather trends are based on observations and experiences in the northern plains of Montana. I live in Billings [Lat 45.79°N. Lon 108.5°W] which is located between 200-foot (61 m) sandstone cliffs known as the "Rimrocks" and the banks of the upper Yellowstone River in south-central Montana.

For the purposes of this discussion my definition of "regional" is Yellowstone County, of which Billings is the County seat. Yellowstone County covers 2,649 square miles (6,861 square km), making it larger than the state of Delaware, and features elevation ranges of 4,950 feet (1509 m) in the Pryor Mountain foothills to 2,685 feet (818 m) near the confluence of the Bighorn and Yellowstone rivers. A recent local newspaper story aptly described the difference between these two respective locales: "It's a country brutally cold in mid-winter and scalding hot in late summer with a long way between the shade of any trees or the trickle of running water ... Here, mammoth cottonwood trees grow fat on a steady diet of river water, providing shade to thick undergrowth, whitetail deer, and mammoth beavers." (*Billings Gazette* 9/20/2014).

In addition to the mammoth beavers, 150,000 "human animals" of my region live in a USDA PHZM 4 (updated 2012-4b Zone) that has over the past 65 years produced an urban canopy dominated by green ash (*Fraxinus pennsylvanica*) trees growing in alluvial soils that are slightly alkaline (pH 7.2-7.4) but relatively rich in organic matter. A glance at the climate summary over the past 119 years shows that the annual average precipitation totals 13.39 inches/35.5 cm and the average annual snowfall totals 27.1 inches/69 cm. May and June are the wettest months (4.63 inches/12 cm total) with December and January being the snowiest and coldest months (average minimum temperature 12.3°F/-10°C).

With this background in mind, what are the weather and climate trends I see? And how has this affected my tree species selection and urban forest management? Over the last ten years my semi-arid region has endured adverse economic, social, and environmental effects from meteorological, agricultural, and hydrological drought. Notwithstanding that the winter of 2012-2013 produced a record snowfall of 100 inches/250 cm that eased hydrological drought (reservoirs, lakes, and river streamflow levels have been adequately replenished), the lion's share of that moisture ran off or evaporated before it sank into the roots of thirsty urban and community trees.

Generally speaking, we don't experience as often the winter deep-freeze temperatures (-20°F/-29°C) that last for several days, yet the mid-to-late summer temperatures have continued to be hot and dry (>85°/29°C and <30% relative humidity). We definitely have experienced an increase in drastic short-term daily temperatures changes, particularly in the spring and autumn months. For example, in October of 2009, the temperature went from 75°F/24°C to 2°F/-17°C in less than 18 hours, and this past September we felt the temperature drop from 90°F/32°C to 30°F/-1.1°C over a 24-hour period. In short, the climate has stayed reasonably true but daily weather attributes are highly variable.

Tree species selection. As previously mentioned, I live in a geographically large rural-urban interface region where numerous and constant factors such as altitude, solar aspect, and proximity to bodies of water create varied micro-climate venues. These venues are not, in my opinion, characteristic of USDA plant hardiness zones 4-4b. I also take stock in Michael A. Dirr's assertion that "One should never allow hardiness ratings to solely determine whether he/she will use a specific plant. Since plants have not been known to read what is written about them in terms of hardiness, they often surprise and grow outside of their listed range of adaptability."

Accordingly, since 2010 I've trialed several bare root, adventive (introduced but not fully naturalized) tree species that are commonplace in most other states but are rarely found in the windy plains of south-central Montana. (Note: all trees are sprayed with a 10% anti-desiccant spray in late November and early February and low salt, slow release nitrogen fertilizers are applied in April and October.)

Katsuratree (*Cercidiphyllum japonicum*) has survived -30°F/-34°C winter temps. Tip dieback is common and full sun is a stress factor. They are performing better in partial shade with protection from drying winds. Organic mulch has improved their thriftiness by moderating seasonal soil temps. A severe storm that produced golf ball-sized hail propelled by 70 mph (113 kph) sustained winds on September 7, 2013 outright killed exposed trees. They require 20 gallons (76 L) of water per week to sustain themselves throughout July and August.

English oak (*Quercus robur* 'Fastigiata') has survived -30°F/-34°C winter temps. Two flushes of growth average 5-6 feet (1.5-1.8 m) of terminal height. Second flush around mid August tends to be susceptible to early or late season frosts. Lost an average of 7 feet/2.1 m due to the September hailstorm but have rebounded nicely and are standing tall at 12-13 feet (3.6-3.9 m). Seven out of ten are true to form (tightly upright); two died, and one oak is destined to be a short, stubby shrub! Only need 5 gallons (19 L) of water weekly and it appears they don't like "wet feet."

Lacebark elm (*Ulmus parvifolia*) has survived -30°F/-34°C winter temps. Averages 4-5 feet/1.2-1.5 m terminal growth but severely damaged (broken & cankered branches) by September hailstorm. Have rebounded nicely this past season and thrive in full sun with moderate water (5 gal/19 L) per week. Beautiful red leaves in October.

Dawn redwood (*Metasequoia glyptostroboides*) has survived -30°F/-34°C winter temps. Averages 4 feet/1.2 m terminal growth but severely damaged by September hailstorm. They thrive in full sun but I take time to mist the foliage daily to ease stress from searing and dry summer winds. Distal shoots are susceptible to winter conditions but push out new growth by mid-May. I've never seen an aphid or mite on these trees!

—Mike Garvey, Registered Consulting Arborist, Garvey's Urban Forest, Billings, Montana

Sturdy oaks withstand extreme weather events better than many other species. This bur oak (*Quercus macrocarpa*) was photographed by Guy Sternberg; note tiny human for size reference.

The weather trends we have experienced in Philadelphia have influenced the **way** we manage our urban forest far more than **what** we plant. These trends have forced us to focus on public safety issues, as well as modifications to our planting specifications to ensure maximum canopy growth so that our urban forest remains stable.

Our weather over the past decade confirms the best available climate information for Philadelphia which suggests warmer and wetter conditions for all seasons. Heat events and hot days are projected to increase quite substantially by the end of the century, while precipitation events do not show a marked increase in intensity or frequency, except in winter. Milder winters may reduce cold-related deaths of citizens, but warmer summers may increase heat-related deaths of vulnerable populations. Increased summer temperatures may also lead to an increase in the formation of ground level ozone, increasing the incidence of respiratory ailments. Therefore, we are focusing our tree planting efforts for both street trees and our yard tree program on neighborhoods in the city with low tree canopy. These often correspond to lower income areas of our city, where there the impacts of temperature extremes take the highest toll.

The other public safety issue is tree damage during storm events. Philadelphia experiences intense precipitation due to strong thunderstorms, tropical storms, hurricanes, Nor'easters, and winter snowstorms. Philadelphia has been hit by five major hurricanes and storms in the past ten years. In addition, a number of major snowstorms have occurred recently, with four of the ten biggest snowstorms of record hitting Philadelphia during the past decade.

With an aging tree population (many of our street trees were planted soon after Philadelphia formalized its street tree program in 1901), it is critical that we identify and remove as many dead and dying older trees as possible to prevent them falling on power lines and blocking streets and homes. We have had to balance funding between planting and removals in order to manage the maintenance required to keep our street trees safe.

We have also made changes to our planting specifications to ensure that when we do plant trees, they have the best chance of growing to maturity. Recently planted trees rely heavily on root ball soil moisture throughout the first growing season, and adequate watering is the most important maintenance practice in order to ensure establishment of newly planted trees. Three years ago we began requiring summer weekly watering of all trees during the first year. In addition, soils in new tree pits must be replaced with a specified manufactured soil to promote water absorption.

Because of our location in the mid-Atlantic, we don't anticipate significant shifts in the conditions for our tree species. However, we are beginning some experimentation with trees that are in the southern part of our eco-region, to test how they do here in the long term.

—Joan S. Blaustein, Director, Urban Forestry and Ecosystem Management Division, Philadelphia Parks & Recreation

The entrance to the J. Sterling Morton estate demonstrates how to create an allée of diverse trees. Photo by Guy Sternberg

Stretching more than 3000 miles (4828 km) south from south-central Florida to the coastal Amazon rainforest in Brazil, the tropical mangrove swamp is one of the largest continuous ecosystems in the Western Hemisphere. Historically, the northernmost mangroves on the Atlantic coast of Florida were just north of the Indian River lagoon around Kennedy Space Center, approximately 175 miles (282 km) south of the Georgia border, with a few small single pioneers reaching into north Florida.

But according to recent data presented by the GTM-NERR (Guana Tolomato Matanzas-National Estuarine Research Reserve, a division of NOAA and the Department of Environmental Protection), the northernmost black mangrove (*Avicennia germinans*) is now located in northern St. Augustine, approximately 60 miles (97 km) south of the Georgia border on the Atlantic Coast. According to a 2013 study from the Smithsonian Environmental Research Center using data gathered over the last 28 years, "... the area of mangrove forests has doubled at the northern end of their historic range on the east coast of Florida." (*Smithsonian* Vol. 111, No. 2). This expansion appears related to a lack of consistent extreme (relatively speaking) periods of cold.

Until 10 years ago, mangroves were handled largely by arborists and developers in south Florida. Most arborists and landscapers in north Florida rarely encountered mangroves, but as current environmental trends continue, arborists in once freeze-prone areas of northern Florida are becoming better versed in managing the persistent tropical mangroves. Black mangroves 20-30 feet (6 to 9 m) in height are now not uncommon in north Florida.

But thanks to the Mangrove Trimming and Preservation Act of 1996, few broadleaf trees in the United States are as protected as mangroves are in Florida. According to a panel of attorneys at a recent state seminar on mangrove management in West Palm Beach, not even sequoias on the West Coast are as heavily protected. Improper pruning, removal, or damage of mangroves carries a minimum fine of $5,000 per tree, a fee that makes even wealthy developers think twice before clearing waterfront parcels for their even wealthier clients. This means more homeowners are hiring qualified arborists to trim their mangroves to maintain their waterfront views. As with other trees, proper pruning is critical for mangroves to maintain proper structure and good health.

The most numerous species of mangrove in Florida is the red mangrove (*Rhizophora mangle*), but the most abundant mangrove in north Florida is the black mangrove due to its greater cold-tolerance threshold. All three mangrove species including the very cold sensitive white mangrove (*Laguncularia racemosa*) can now be found in St. Johns County, approximately 75 miles (121 km) south of the Georgia border on the Atlantic Coast.

Dominated by smooth cord grass (*Spartina alterniflora*), cold tolerant salt marsh is slowly being outcompeted for sunlight by the increasingly taller and more dense mangrove swamp. As the northern movement of mangroves continues, this will have large implications for Florida's ecology and economy. Because a large number of plants and animals including many species of fish are associated with either only mangrove swamps or salt marshes, a distinct change in both coastal flora and fauna is currently taking place.

Mangroves sequester more carbon dioxide than marsh grasses, but marshes produce much larger amounts of detritus, the organic fuel for fisheries. Estuaries are the nurseries for the oceans and fisheries are Florida's second largest economy after tourism. Both commercial and recreational fishing combined generate approximately 10 billion dollars annually in revenue for the state—more than the citrus industry. Money talks and private homeowners as well as private and governmental organizations are paying close attention to the northward expansion of the tropical mangroves.

—Daniel Lippi, Consulting Arborist, ISA Certified Arborist, Advanced Tree Care, Inc., St. Augustine, Florida

There is widespread agreement that our changing climate will affect the habitat to which our trees have become adapted here in the Northeast. Changes regarding factors like extreme weather events, temperature, atmospheric CO_2 concentrations, and precipitation levels have the potential to drastically alter ecosystems and the way their associated population communities respond. Can we know which tree species will thrive and expand their range under these conditions, and which tree species will ultimately decline?

We know that the species composition of our urban and community forests are often strongly correlated with the species types of the surrounding native forestland areas. In fact, the vast majority (over 75%) of the native trees in our urban forests are within the latitudinal range of their forested range. Thus, we can examine what researchers predict will be the outcome of our changing climate on traditional forested lands to get some sense as to how this may impact the community forests that we have helped to establish and maintain in the built environment.

First, let's look at the climate and what we have recorded since we have been keeping formal records since the late 1800s. Since that time, we in the Northeast have noted a significant increase in average annual temperature (+ 1.44 deg F) and precipitation levels (+ 3.7 inches/9.4 cm), with progressively less snow cover and a longer growing season that has featured more large-scale precipitation events (an 8% increase).

Many of these notable differences in weather trends over the last 100+ years are predicted to continue into the future. Thus, the growing season is expected to get longer and warmer and extreme weather events are predicted to increase to include prolonged periods of drought and isolated events of increased precipitation intensity. Also, winter snow cover period is predicted to continue to shorten through the end of the century, to the point where it may only be about 50% the length that it is today.

Researchers have already begun to notice changes in plant communities believed to be associated with altered weather patterns. Recent studies in the more northerly forested ecosystems of Canada, Alaska, and Siberia have already pointed to a more northern and upslope migration of certain tree species. Here in the northeast U.S., these same trends have been noted, even on a relatively local scale as northern hardwood forest-type plants have replaced their boreal counterparts at higher elevations in more mountainous settings.

For species that dominate the more southern forest types like the oak-hickory hardwood and oak-pine mixed forests, habitat suitability is predicted to increase here in the Northeast, as many experts expect a general, long-term, northward "shifting" of habitat. This may occur, however, largely at the expense of the habitat more suited to the northern hardwood (maple-beech-birch) and northern mixed (aspen-birch, white-red-jack pine) forest types. Not a surprise, many of the oaks (*Quercus* spp.) and pines (*Pinus* spp.) found in these more southerly forest types are predicted to potentially thrive and expand under these suitable conditions.

Some of our most cherished trees species that are characteristic of our Northeast forests like sugar maple (*Acer saccharum*), beech (*Fagus americana*) and yellow birch (*Betula lutea*), however, are predicted to lose considerable amounts of suitable habitat. The same holds true for other associated species that we may even find planted in urban settings, like white birch (*Betula papyrifera*), black maple (*Acer nigrum*), arborvitae/eastern white-cedar (*Thuja occidentalis*) and white spruce (*Picea glauca*).

If longer, more intense growing seasons and shorter, warmer winters are making it less suitable for some of our northern tree species, what specifically can be done to maintain—and even improve—the health of our current urban tree populations? Urban foresters may be able to provide some relief to the existing tree populations by using best management practices that help alleviate the environmental stresses associated with a changing weather pattern. This can be as simple as timely watering(s) and the use of mulch to protect root systems and the lower stem area of a tree. Another example is that mature specimens may not require supplemental fertilizer applications as this may "push" them to grow when in fact they should be concentrating their limited resources on persisting through a difficult growing season.

Knowing what tree species are expected to do well if predicted climate trends hold, tree selection here in the Northeast may indeed be revised by urban tree managers and arborists to include the planting of specimens that are currently more indigenous to points further south. Some of these trees may include sweet gum (*Liquidambar styraciflua*), baldcypress (*Taxodium distichum*) and any number of the more common southerly oak trees like willow oak (*Quercus phellos*) and turkey oak (*Quercus laevis*). Some tree species that may continue to do well under future climate change scenarios, like honeylocust (*Gleditsia triacanthos*) and the non-indigenous ginkgo (*Ginkgo biloba*) are trees that have been widely established in the urban environment here in the Northeast for quite some time.

Simply because environmental conditions conducive to a given forest type may be predicted to expand, that doesn't necessarily mean that the trees characteristic of that forest type will actually "move" to occupy these "new areas." Movement of seed, for example, of many of our northern hardwood types is dependent on wind; the seed of many of our more southerly oak-hickory forest types is vectored by wildlife. Hence, will other important factors like wildlife populations adapt to help disperse seeds of these trees in a more northerly direction? What about the insect populations that are critical to pollination of many of our trees—what will their adaptation strategies include? Or perhaps there will be unforeseen challenges that arise due to differences in soil types of the Northeast? Will opportunistic invasive tree species like *Ailanthus altissima* expand much more rapidly, exploiting and colonizing the new ecological "niches" that begin to present themselves?

—Rick Harper, Extension Assistant Professor, Department of Environmental Conservation, University of Massachusetts-Amherst

Roundtable contributor Guy Sternberg, featured here with a Japanese crape myrtle (*Lagerstroemia fauriei*), speaks widely on trees and climate change and many other topics. With his wife he cofounded and manages Starhill Forest Arboretum (*www.starhillforest.com*) and he wrote the book, *Native Trees for North American Landscapes*.

Sources for Rick Harper's review:

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