

Growing Greener: Eco-Structure For Climate Resilience

Chapters 6-7: Regional & General Resources For Improving Forest Health



Credit: Flickr user Yinghai

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This guide was developed by Kara E. Reeve, Manager of National Wildlife Federation's Climate-Smart Communities Program, with support from additional NWF staff including Ian Evans, Patty Glick, Laura Hickey, Ryan Kingston, and Jennifer Murk. Information about NWF's Climate-Smart Communities Program can be found here: www.nwf.org/climate-smart-communities.

Introduction

Whether you live in the city overlooking a park, grew up with a backyard tree house, or have hiked in a national forest, you undoubtedly know exactly what poet Joyce Kilmer was feeling when he wrote, "I think that I shall never see a poem as lovely as a tree." Trees are a vital part of our natural world, health, economy, and culture.

The ecological benefits of healthy trees, including the habitat, shelter, and food they provide for many birds and small wildlife, are widely known.

However, people living in urban areas may not immediately consider the ways in which healthy urban forests are **critical infrastructure** for *human* communities, too.



Credit: Charlie Archambault

For starters, trees are central components of green infrastructure, which is a natural and cost-effective approach that many communities are using to reduce flooding, manage stormwater, improve water quality, and even reduce urban heat. Green infrastructure includes a mix of landscape features including tree canopies, open space, parks, and wetlands, as well as low impact development (LID) approaches, such as rain gardens, green roofs, and permeable paving. Additionally, planting and fostering healthy trees helps reduce carbon pollution because as trees grow, they absorb carbon dioxide from the air and store carbon in their trunks, roots, and foliage. Furthermore, communities are already experiencing the effects of climate change, including extreme flooding, heat waves, and drought, and green infrastructure can provide critical, natural protection from these impacts now and into the future.

Green infrastructure not only provides resilience to climate change, but can also help communities be more resilient to economic shocks since designing, installing, and maintaining green infrastructure projects, like green roofs and rain gardens, can lead to new local job opportunities. Additionally, green infrastructure often costs less to install and maintain when compared to conventional "grey" infrastructure, such as building underground storage tanks to manage stormwater, and buildings with vegetated roofs benefit from lower heating and cooler costs.¹ Green infrastructure also improves the health and quality of life for residents by improving access to green spaces, connecting people with nature, and by providing recreational opportunities.

¹US EPA. *Reducing Urban Heat Islands: Compendium of Strategies*. Chapter on Green Roofs. URL: <http://www.epa.gov/heatisland/resources/pdf/GreenRoofsCompendium.pdf> (accessed 2 May 2013).

NWF partnered with King County, Washington, to help develop an on-line tool for landowners, called Urban and Community Forestry CPR - Climate Preparedness and Response (CPR).² Using CPR, landowners can view their own property using a Geographic Information System (GIS) tool. Once a property has been identified, the tool also quantifies and explains existing land and forest characteristics (e.g., total forest carbon stored at a particular site). Additionally, the website provides customized management recommendations through a Forest Health Assessment survey.

This guide is designed to help local governments, organizations, and others replicate the website and tool for their own communities, while also learning about the ways in which green infrastructure can provide natural protection from the impacts of climate change. The first section of this guide provides an overview of the ways in which climate change is impacting urban areas, and also describes how nature-based approaches, like enhancing and protecting the urban tree canopy, can help communities build resilience to climate impacts. The next section includes a case study of the King County Forest CPR development process, guidance for selecting data sources for the tool, and lessons learned from the King County project. Next, since climate change is impacting the survivability of urban trees, this guide also provides recommendations for integrating climate change considerations into the planning for and management of urban forests. This guide also includes a chapter about managing for pests in a changing climate, while the next section profiles National Wildlife Federation programs and resources that are designed to build healthy, resilient communities, including NWF's Certified Wildlife Habitat[®] program. The last sections include regionally-specific resources and information to help enhance forestry health and subsequently increase the amount of carbon that urban trees are able to sequester.

We have developed this guide to encourage cities and towns to recognize trees as critical, functional infrastructure —“**eco-structure**”—that is just as important as buildings and roads. We know that trees can survive and thrive in urban areas, while benefiting the humans that live there — we just need to place a premium on our trees and other green infrastructure and envision a greener, healthier future.

² Forestry CPR can be accessed here: <http://gismaps.kingcounty.gov/ForestryCPR/>

6. Regional Resources For Improving Forest Health

Northeast (New York)

As mentioned previously, urban trees are already challenged to survive in urban areas, and climate change provides additional stressors. Cities in northern regions, such as New York, must have trees that must not only withstand the changing seasons on an annual basis, but also the man-made stressors that come with these seasons. Namely, trees must be tolerant to salt that is used to manage snow and ice. As the overall climate changes, these trees must also be able to withstand the increased temperature and more intense storms that are expected for the region.

Planning: PlaNYC is New York City's long-term, master sustainability plan. Among the many initiatives to reduce its vulnerability to climate, the Million Trees NYC initiative includes a goal to increase the number of trees in the city. Residents can volunteer at planting events, receive free trees to plant from the New York Restoration Project, report planting opportunities, and contribute on their own to reach the cities one million tree goal. <http://www.milliontreesnyc.org>

TreesNY is a local nonprofit that promotes and supports the City's urban forest through education, volunteer events, and various programs. Their site also offers tree care tips, and locals can register as Citizen Tree Pruners through their training programs. <http://www.treesny.org/citizenpruner>

Research: The New York City Urban Field Station of the Forest Service conducts and supports research in urban ecosystems. This research involves the surveying urban trees, studying resilience, health, and well-being of individuals and communities, and promoting environmental literacy. Researchers may also use the field station to conduct research to contribute to our understanding of urban forests. <http://nrs.fs.fed.us/nyc/>

Tree List: New York City has developed a species list of trees that can be planted within the city. While not all are native, these trees are tolerant of the harsh conditions characteristic of urban environments. The city has also made note of species that are vulnerable to invasive pests such as the Asian Long-Horned Beetle. <http://www.nycgovparks.org/trees/street-tree-planting/species-list>

Trees & Climate Change: The US Forest Service has developed a Climate Change Tree Atlas (A Spatial Database of 134 Tree Species of the Eastern USA). In conjunction with the tree planting list for New York City referenced above, this atlas can be used to develop an urban tree species list that includes trees that are not only appropriate for the urban environment in New York, but that will also be able to withstand future climate conditions in the city. The Climate Change Tree Atlas can be found here: http://www.nrs.fs.fed.us/atlas/tree/tree_atlas.html#

State-level Resources

The New York Forest Owners Association focuses on forestry practices of local landowners. With local chapters located throughout the state, their events and educational materials help promote the growth and maintenance of healthy forests on private land. http://www.nyfoa.org/about_nyfoa/index.php

New York State's Department of Environmental Conservation offers several resources to educate and promote the planting and protection of native trees. Links on this site include information on aquatic plant management, the State's tree nursery, and federally and stat- protected plants.

<http://www.dec.ny.gov/animals/275.html>

NY DEC's Office of Climate Change works on mitigation and adaptation throughout the state, and partners with local groups in several areas. The "Important Links" tab on the right side of the page leads to resources related to general information on climate change at the global, state, and local levels. The Climate Smart Communities page contains webinars and guides to local action, all related to making local communities more adaptable to climate change. <http://www.dec.ny.gov/about/43166.html>

Forestry Contacts & Local Resources:

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New York City Urban Forester:
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NYS Dept. of Env. Conservation
Division of Lands & Forests
625 Broadway, 5th Floor
Albany, NY 12233
518-402-9425

City of New York Parks & Recreation
<http://www.nycgovparks.org/trees>

Mid-Atlantic (Baltimore)

The Mid-Atlantic region is subject to a mix of tropical and winter storms, many of which are expected to worsen as the climate changes. Cities along the coast, such as Baltimore, must also plan for sea level rise and increased storm surge. Urban forests here must combat hot summers compounded by the heat island effect, resist increased salinity from salt used to manage road ice, and must be resilient to storms of all types.

Planning: TreeBaltimore, like Million Trees NYC, is a component of Baltimore's Office of Sustainability. Their goal is to double the city's tree canopy from 20 to 40% by 2037 through programs such as tree giveaways, developing educational programs, and increasing plantings in public. Designated "Healthy Neighborhoods" may qualify for free or half-price trees to help increase home values and improve their property. Residents can also request street trees in public areas or volunteer at plantings to help Baltimore reach its tree canopy goals. <http://treebaltimore.org/>

The City has also developed a series of maps to show tree cover throughout the city. Maps such as these can help landowners and city planners decide where future trees should be planted.

<http://bcpr.baltimorecity.gov/ProgramsandInitiatives/TreeBaltimore/Maps.aspx>

Research: The Baltimore Ecosystem Study, funded by the National Science Foundation, focuses on the interaction of environmental features, built structures, and social factors. Studies range from analyzing metal concentrations in urban riparian zones to the linkage between environmental justice and urban forest biodiversity. The results of these various studies may help inform decisions on land use in the urban environment, and provide background on the benefits of urban forests: <http://beslter.org/>

The University of Delaware has conducted research in the Mid-Atlantic region to categorize native and alien plant genera in terms of their ability to support insect herbivores, and thus overall biodiversity. Insects in the Order Lepidoptera, which includes moths and butterflies, were chosen as surrogate species for all insect herbivores. The results of this study can be used to determine which plants support the most invasive insects, and can thus be avoided when urban trees are planted.

<http://udel.edu/~dtallamy/host/index.html> (Results found in Downloads section)

Tree List: The City of Baltimore is currently developing a climate-smart trees species list, which will be included in its Hazard Mitigation and Adaptation Plan, to be completed in 2013.

In the meantime, the City of Baltimore's Recreation and Parks Department developed a list of approved trees to be planted in the city. Although not all are native species, these trees are tolerant of urban environments.

[http://bcpr.baltimorecity.gov/Portals/Parks/documents/Baltimore City Approved Tree List.pdf](http://bcpr.baltimorecity.gov/Portals/Parks/documents/Baltimore%20City%20Approved%20Tree%20List.pdf).

The National Tree Benefit Calculator can be used to determine a tree's economic and health benefits, including in stormwater management, property value, energy, air quality, and CO₂. The state of Maryland adopted this tool to apply directly to the state. Users can input several trees to view the total benefits of trees on their property. This tool can be used to determine the benefits of specific trees in a

region, and to determine if one species may be more beneficial than another.

<http://www.trees.maryland.gov/calculator.asp>

Trees & Climate Change: The US Forest Service has developed a Climate Change Tree Atlas (A Spatial Database of 134 Tree Species of the Eastern USA). In conjunction with the tree planting lists above, this atlas can be used to develop an urban tree species list that includes trees that are not only appropriate for the urban environment, but that will also be able to withstand future climate conditions in the city.

http://www.nrs.fs.fed.us/atlas/tree/tree_atlas.html#

The City of Baltimore developed a simple guide of best practices for planting trees. This can be applied to planting in almost any environment.

<http://bcrp.baltimorecity.gov/ProgramsandInitiatives/TreeBaltimore/TreePlantingTips.aspx>

State-level Resources

The Maryland Urban and Community Forestry Committee (MUCFC) Grants program helps community groups fund tree planting and education projects statewide to enhance Maryland's urban forest.

<http://www.dnr.state.md.us/forests/programs/urban/MUCFCgrant.asp>

The Maryland Department of Natural Resources has compiled information on Urban and Community Forestry that applies specifically to Maryland cities and towns. This site lists laws that protect trees, volunteer opportunities for Maryland residents, recognition programs, and publications.

<http://www.dnr.state.md.us/forests/programs/urban/>

Tree-Mendous Maryland sells trees and offers planting and care tips.

<http://www.dnr.state.md.us/forests/treemendous/ordertrees.asp>

The Maryland Commission on Climate Change was created under an Executive Order signed by Governor O'Malley. This commission released a Climate Action Plan in 2008, which describes future climate change impacts, reduction strategies, and adaptation.

<http://www.mdclimatechange.us/MCCC.cfm>

Forestry Contacts & Local Resources

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Other contacts: http://beslter.org/frame2-page_13.html

Southeast (Broward County, FL)

Broward County, FL, is located on the southeast coast of the state, and includes large urban centers, such as Fort Lauderdale, wedged between the coast and the Everglades. Urban trees in locations such as this are vital for managing stormwater, combating the heat island effect year round, and are subject to extreme heat, drought, and intense storms. Urban forests in the southeast must not only provide vital ecosystem services, but must be resilient to extreme weather, especially as the climate changes. As of April 2013, Broward County has more NWF Certified Wildlife Habitats® than any other place in the country.

Planning: Broward County enacted a Tree Preservation Program to manage ordinances related to urban trees. This program also arranges public outreach projects such as tree giveaways, educational seminars, and school presentations.

<http://www.broward.org/Regulation/Engineering/Pages/TreePreservationProgram.aspx>

The Florida Urban Forestry Council promotes sound urban forestry policies and practices by educating citizens and communities throughout the state. This nonprofit offers workshops and conferences to disseminate the best practices of urban forestry, and offers resources for citizens, city planners, and other interested parties. <http://www.fufc.org/index.html#>

The Urban Forest Management Plan for Broward County offers several resources and information related to urban forestry and best practices. The site contains links to resources related to forest assessments, forest enhancement, wind resistant trees, and tree canopy coverage.

<http://www.broward.org/NaturalResources/LandStewardship/UrbanForest/Pages/Default.aspx>

Research: Florida and other southeastern states are regularly damaged by tropical storms and hurricanes. Managing and restoring damaged trees is one factor these states must take into account in their urban forestry plans. The University of Florida Institute of Food and Agricultural Sciences Extension has conducted research on the subject, and offers step-by-step guides for restoration.

http://edis.ifas.ufl.edu/topic_trees_and_hurricanes

Tree list: Florida-Friendly Landscaping is a statewide initiative to encourage homeowners, property managers, and professionals to use plants that are more sustainable in terms of time, money, and energy requirements. Their Plant Database allows individuals to choose their region, desired plant type, and growing conditions to determine which plants work best. <http://floridayards.org/fyplants/index.php>

The Institute for Regional Conservation provides detailed data on habitats and plants found in specific regions in South Florida. Users input their zip code or chose a county to find lists of native plants for that region. <http://regionalconservation.org/beta/nfyn/default.asp>

Broward County government developed a short list of trees that have a history of performing well during recent storms. Several factors determine how well a tree will fair, as this site describes, but this list offers a starting point for post-storm restoration.

<http://www.broward.org/Parks/Extension/CommercialHorticulture/Pages/Replant.aspx>

The Florida Native Plant Society developed an interactive map that allows users to determine the right plants for their region, based on hardiness zone, environmental needs, and optional attributes such as hurricane resistance. <http://www.fnps.org/plants>

Trees & Climate Change: The US Forest Service has developed a Climate Change Tree Atlas (A Spatial Database of 134 Tree Species of the Eastern USA). In conjunction with the tree planting lists above, this atlas can be used to develop an urban tree species list that includes trees that are not only appropriate for the urban environment, but that will also be able to withstand future climate conditions in the city. http://www.nrs.fs.fed.us/atlas/tree/tree_atlas.html#

State-level Resources

Urban Forestry South is part of the Forest Service's Southern Research Station. Their site provides resources specifically for southern areas, including published scientific papers, tools for urban forestry planning, and contacts for additional resources. <http://www.urbanforestrysouth.org/>

The Florida Forest Service is responsible for protecting the state and its people from wildland fire and to manage forest resources through a stewardship ethic. Their site offers educational materials, trainings and classes, and general information on state forestry. http://www.floridaforestservice.com/training_education/index.html

The Florida Forestry Association is a member-based organization that advocates for and promotes sustainable forestry in the state. Several programs are done in partnership with the nation-wide Sustainable Forestry Initiative. They also offer information on local tree farms to support native species in the state, under the "Programs" tab. <http://floridaforest.org/>

The Florida Climate Center is the state's primary resource for climate change data. Past temperature and precipitation data as well as future projections are available for different regions across the state. <http://climatecenter.fsu.edu/topics/climate-change>

Forestry Contacts & Local Resources

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850-488-4274

Natural Resources Planning and Management Division
Land Stewardship Program
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Fort Lauderdale, Florida 33301
Phone: 954-519-0305

Florida-Friendly Landscaping Program
University of Florida, Institute of
Food & Agricultural Sciences
Environmental Horticulture Dept.
Gainesville, FL 32611-0675
Phone: (352) 273-4518
Fax: (352) 392-1413

Midwest (Chicago)

Chicago is located near the southern edge of Lake Michigan, at the intersection of the Midwest and Great Lakes regions. As the climate warms, lake levels are expected to decrease as the snowpack that feeds them decreases. When precipitation does occur, however, it is more likely that it comes in the form of intense storms. Flooding along the coast is more likely in these cases. In the Midwest, developed areas must prepare for more frequent tornadoes and longer droughts. Urban forests here can offer shade to combat the urban heat island effect, conserve water, and offer a barrier to wind. Trees planted, however, must be resilient in the face of this extreme weather.

Planning: The City of Chicago developed a plan entitled “Climate Considerations for Management of Natural Areas and Green Spaces.” This report acts as a guide in implementing climate-smart land management and offers methods for safeguarding species and systems from future impacts. The full report offers useful insights, and can be used as a template for other cities. The annotated list of tools and resources also provides a number of useful resources for the region.

https://adapt.nd.edu/resources/1107/download/Climate_Considerations_Chicago_FINAL.pdf

To address the broader needs of conservation, the Chicago Wilderness alliance developed the “Chicago Wilderness Climate Action Plan for Nature.” This plan addresses three major areas: mitigation strategies, such as using natural areas for sequestering carbon, making natural areas more resilient, and engaging the Chicago Wilderness community in action. A summary of the plan can be found here:

http://www.chicagowilderness.org/files/2213/3035/6961/Climate_Action_Plan_for_Nature.pdf

The City of Chicago’s Sustainable Backyards Program is an educational and incentive program that encourages residents to create environmentally-friendly landscapes in their backyards. Through a series of classes, workshops, and incentive programs, the city is able to encourage the growth of green spaces on private property. Information on the program, including how the rebate program works, is found on the city’s website.

http://www.cityofchicago.org/city/en/depts/cdot/provdrs/conservation_outreachgreenprograms/svcs/chicago_sustainablebackyardprogram.html

Research: The Chicago Wilderness alliance developed an appendix of information related to climate change impacts and natural communities. This appendix is supported by the latest scientific literature, and can be used to inform adaptive management in a rapidly changing environment. This web page is dedicated to impacts on plants and natural communities, with links to other resources, such as wildlife, green infrastructure, and general adaptation strategies located on the left side of the page:

<http://climate.chicagowilderness.org/index.php?title=Plants>

The U.S. Forest Service collaborated with the City of Chicago to carry out an I-Tree analysis of the City’s urban forest. This report details the forest structure, potential risk to the forest from pests, effects on air pollution and carbon storage, and changes in building energy use. Reports such as this can inform future management decisions, especially if the forest must be improved or changed to adapt to climate change. The full report can be found here: http://www.nrs.fs.fed.us/pubs/rb/rb_nrs37.pdf

Tree list: The City of Chicago has developed an Urban Tree Planting List. This list identifies species with

the potential for invasiveness, suggests planting sites, and marks trees that are salt tolerant, are best grown in the spring, and those that promote diversity. In addition, the species availability, hardiness, and ease of transplant are ranked. The City is currently updating their list to identify which species are native to Illinois, and their climate readiness. The latest list can be found on this site:

http://www.cityofchicago.org/city/en/depts/streets/provdrs/forestry/svcs/tree_planting.html

State Level Resources

The University of Illinois Forestry Extension offers several resources related to urban forestry. Aside from a list of general benefits, their site links to several helpful resources related to pruning, youth education, and tree and shrub selection.

http://web.extension.illinois.edu/forestry/urban_comm_forestry.html

The Wisconsin Initiative on Climate Change Impacts released a comprehensive report on impacts and adaptation in the state. This extensive report maps out projected impacts to natural and built systems and offers adaptation actions. Much of the information gathered for this state can be applied to the rest of the region. <http://www.wicci.wisc.edu/publications.php>

Forestry Contacts & Local Resources

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Southwest (Texas – Houston and Austin)

The southwest's hot, dry climate is expected to worsen as the climate warms. Cities in this area can be two to nine degrees hotter than the surrounding area due to the constant sun and the high density of paved surfaces. The urban forest in these areas must be extremely tolerant to heat and drought, while providing a defense against the sun.

Planning: The City of Houston has developed several resources for best practices and tips for tree plantings that are particularly relevant for the southwest climate. Many of the tips here can be applied to the surrounding region. <http://www.houstontx.gov/parks/pdfs/treeplanting.pdf>

Tree list: The Houston Parks and Recreation Department encourages residents to take advantage of the NeighborWoods Program, which provides volunteers with free trees to plant on city right of ways. Interested residents can fill out this brochure, which contains a short list of trees available. <http://www.houstontx.gov/parks/pdfs/neighborwoodsbrochure.pdf>

The Austin Parks and Recreation Department developed a Native Tree and Plant guide with a variety of notes, including native range within Texas and water needs. <http://www.austintexas.gov/sites/default/files/files/Watershed/growgreen/plantguide.pdf>

The Texas Bayou Region Tree Guide offers a list of tree species that thrive in the bayou region, namely in the southeast corner of the state. Many of these trees can be used to enhance the urban forest. <http://www.haufc.org/treeguide/home.html>

TreeFolks of central Texas developed a simple tree guide for planting native species in central Texas. This brochure shows pictures of trees that should be planted, and comments on the health concerns and benefits of the different species. <http://treefolks.org/wp-content/uploads/2011/05/Native-Guide-LowRes.pdf>

Trees & Climate Change: Texas Climate News offers a series of articles related to how climate change will specifically impact Texas, and articles related to local politics on the issue. This article outlines some of the recent national Climate Assessment and its specific implications for Texas. Data here can be used to inform decisions on species plantings in the region. <http://texasclimateneeds.org/wp/?p=6473>

State-level Resources

Texas A&M Forest Service works with local communities to develop urban forests. Their website offers resources such as local contacts, ordinance tutorials, and local studies and inventories. <http://texasforestservice.tamu.edu/main/article.aspx?id=1279>

The West Texas Urban Forestry Council offers tree care tips, arranges programs and events, and gives away free trees based on an application process. Their simple tree selection tool allows users to find trees based on one or several attributes, such as shade type and water needs. <http://www.wtufc.org/site/treeSelection/index.php>

The Texas Climate Initiative provides general information about climate change impacts in the state of Texas. The book “The Impact of Global Warming on Texas” is available online, and addresses issues such as water resources, biodiversity, and cities.

<http://texasclimate.org/Books/ImpactofGlobalWarmingonTexas/tabid/481/Default.aspx>

Forestry Contacts & Local Resources

Houston Parks & Recreation Department

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Houston, Texas 77023

Phone: 832.395.7000

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Austin Parks & Recreation Department

200 S. Lamar Blvd.

Austin, TX 78716

Phone: 512-974-6700

Texas A&M Forest Service

County, Program, and Location Contacts

<http://texasforests-service.tamu.edu/main/article.aspx?ctrl=20>

Mountain (Denver Metro Area)

As the climate warms and droughts increase in frequency and length, the frequency of wildfires in the Midwest is expected to increase. As with most regions in the country, the frequency of extreme weather is also expected to increase. Mountain regions may see some species disappear and others thrive as higher altitudes begin to match the warmer climate of lower altitudes. In addition, streams and rivers fed by snowpack melt may begin to decline as temperature increases and snowfall rates decrease. Urban forests in these climates must thus be resilient to a variety of impacts, and thrive under varying climatic conditions.

Planning: Greenprint Denver is the Mayor's Sustainable Development Initiative for Denver, CO. As part of this initiative, the city enacted the Mile High Million in 2006, a plan to plant at least a million trees by 2025. This initiative involves educational programs for children, providing resources for educators, organizing volunteer events for plantings, and providing resources for individuals that wish to contribute. <http://www.milehighmillion.org>

American Forests has developed a series of case studies on several cities, including Denver. These studies give an overview of the forestry initiatives and how their programs work. Chapters can be downloaded and read online. <http://www.americanforests.org/our-programs/urbanforests/urban-forests-case-studies/denver-introduction/>

Although environmental, economic and social sustainability are primary goals for the City of Boulder, there is currently no formal written plan that guides forestry or other operations. The Denver metro area has a "million tree" initiative that includes the city of Boulder.

Research: The US Forest Service's Rocky Mountain Region research and management focuses on National Forests and public lands, but much of their research can be applicable to urban forestry, including pest and disease management. The Forest Service also works in State, Private, and Community Forestry. http://www.fs.usda.gov/detail/r2/maps-pubs/?cid=FSBDEV3_041656

The USGS Northern Rocky Mountain Science Center has conducted expansive research on climate impacts on the Rocky Mountain region. Overviews on various impacts, tools, and contacts can be found on their climate website. <http://www.nrmssc.usgs.gov/science/climate>

Tree list: The Mile High Million compiled a series of resources to assist individuals with choosing the correct trees and factors to consider in planting. Fact sheets on this website include lists of plants that may thrive in Colorado, as well as their water and soil needs. <http://www.milehighmillion.org/pages/trees/tree-planting/the-right-tree>

A group of representatives from the Colorado Nursery & Greenhouse Association and partner organizations developed a list of recommended trees for the Colorado Front Range, the region from Colorado Springs to the Wyoming border and from the foothills to the eastern plains. Based on the projected climate impacts for a specific region, this list can be used to determine trees that are most at

risk. For example, trees susceptible to disease and require high amounts of water should be avoided as the climate warms. http://coloradonga.org/articles/Tree_Recommendation_List.pdf

State-level Resources

Colorado Trees offers general information and programs related to native Colorado trees. Their recommendation list provides species and specific regions they should be grown in.

<http://www.coloradotrees.org/find.php>

The Colorado Forestry Association is the state's chapter of the National Woodland Owners Association. Through forestry legislation, education, and the creation of forest reserves, this group supports conservation in the state. Their site has an extensive list of forestry-related agencies, including state government, universities, and nonprofits. <http://www.coloradoforestry.org/links.html>

The University of Colorado in Boulder developed a website with the purpose of educating the public, teachers, and policymakers about climate change. Topics cover climate and weather, water, and ecology, among others. <http://learnmoreaboutclimate.colorado.edu/>

Forestry Contacts & Local Resources

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San Diego County, CA

The west coast of the U.S. faces many similar threats as the east coast, namely sea level rise and exposure to extreme weather events. Many western states must also manage for drought and wildfires that will come to characterize summer months as the climate warms. Urban forests are particularly useful here for providing shade and saving energy in summer months, while also slowing water loss from surrounding soil.

Planning: The Urban Corps of San Diego County provides high school students and graduates with job training and community service opportunities. The Urban Forestry Department works with urban and low-income neighborhoods to plant trees while educating participants on the benefits of trees to the environment. Citizens may also apply for a free tree online. <http://www.urbancorpssd.org/forestry.html>

Research: The US Forest Service Pacific Southwest Research Station is home to an urban ecosystem program with a variety of resources. Their site offers tools and reports on issues such as carbon sequestration, managing invasive species, and best practices. For reports not available online, contacts are listed. <http://www.fs.fed.us/psw/programs/uesd/uep/>

Tree list: The Transportation and Storm Water Department of San Diego has developed a Tree Selection Guide for private landowners and individuals planting on public right-of-ways. This guide gives basic information such as tree form, height, spread, tolerance to drought, and whether or not the species is native. <http://www.sandiego.gov/street-div/pdf/treeguide.pdf>

San Francisco has developed a map of trees in the urban forest. Users can search specific species and locations, and determine the total economic benefits of these trees. San Diego has begun to create its own tree map, with assistance from several nonprofits and partner organizations.

<http://urbanforestmap.org/map/>

Trees and Climate Change: The California-based Urban Forest Ecosystems Institute offers a tree selection guide. Users can find information on a specific species, or input attributes to determine which trees should be used in their plantings. Attributes include USDA hardiness zone, invasiveness capacity, and disease susceptibility. These attributes must be taken into account as the climate changes, and may thus be a helpful planning tool. <http://selectree.calpoly.edu>

In San Diego County, arborists, local governments and volunteers have spent a year mapping the County's urban trees³ to better understand the ways in which the trees provide environmental and financial benefits. Results of the mapping can be found on the website of the San Diego County Tree Map, found here: <http://sandiegotreemap.org/map/> As of May 2013, the 332,010 trees included in the map provide the following aggregate benefits:

³ Murphy, Susan. *Every Tree Counts In Fighting Climate Change, Says Ecologist*. 22 January 2013. KBPS, San Diego State University. URL: <http://www.kpbs.org/news/2013/jan/22/every-tree-counts-fighting-climate-change-says-eco/#.UQFOnAPqx0o.facebook> (accessed 1 May 2013).

Total Benefits: \$6,255,798 saved

Green House Gas Benefits:

- 24,621,928 lbs CO2 reduced
- \$492,438 saved

Air Quality Benefits

- 60,826 lbs pollutants reduced
- \$3,775,337 saved

Water Benefits

- 107,997,249 gallons conserved
- \$197,634 saved

Energy Benefits

- 10,996,793 kWh conserved
- \$1,790,387 saved

State-level Resources

The California Forestry Association promotes conservation and tree plantings in the state. Their site outlines benefits of trees for communities, the economy, the environment, and sustainability. The public can also purchase trees through the California Forest Foundation to support environmental education programs for children. <http://www.calforests.org/community-benefit/plant-tree/>

The California Department of Forestry and Fire Management's Urban and Community Forestry department works to expand and improve the management of trees and vegetation in communities throughout California. Their website offers guidelines for tree growing and care, links to partner organizations, and information on urban and community forestry grants. http://www.fire.ca.gov/resource_mgt/resource_mgt_urbanforestry.php

The California Urban Forests Council is a non-profit dedicated to supporting urban forestry and improving communities. Their website offers several resources, including an exhaustive list of related agencies, policy papers, the benefits of trees, and tree care. <http://www.caufc.org/Resources%20Links>

Forestry Contacts & Local Resources

San Diego Parks & Recreation

<http://www.sandiego.gov/park-and-recreation/index.shtml>

San Diego Urban Corps
3127 Jefferson Street
San Diego, CA 92110
Ph: (619) 235-6884
Toll-Free: 855 SD Corps
Fax: (619) 235-5425

Deborah Chavez
US Forest Service Pacific Southwest
Research Station
Program Manager, Supervisory Social
Science Analyst
(951) 680-1558

7. General Resources About Urban Forests

Carbon Sequestration & Water Management

The Forest Service Center for Urban Forest Research developed a Tree Carbon Calculator in 2011. While still in a pilot stage, the tool provides information on how much carbon is sequestered in a tree based on basic measurements. The tool and several related resources and documents can be found here:

<http://www.fs.fed.us/ccrc/topics/urban-forests/>

<http://www.fs.fed.us/ecosystemservices/carbon.shtml>

<http://www.epa.gov/sequestration/faq.html>

The National Tree Benefit Calculator can be used to determine a tree's economic and health benefits, including in stormwater management, property value, energy, air quality, and CO₂ sequestration. Users input their area code and tree species to determine the economic benefits the tree provides.

<http://www.treebenefits.com/calculator/index.cfm>

In San Diego County, arborists, local governments and volunteers have spent a year mapping the County's urban trees⁴ to better understand the ways in which the trees provide environmental and financial benefits. Results of the mapping can be found on the website of the San Diego County Tree Map, found here: <http://sandiegotreemap.org/map/>

Urban Forestry

The U.S. Department of Agriculture Forest Service Urban and Community Forestry Website:

<http://www.fs.fed.us/ucf/>

Program contacts for State Urban & Community Forestry: http://www.fs.fed.us/ucf/contact_state.html

The Sustainable Urban Forests Coalition website features a list of urban forestry resources:

<http://www.urbanforestcoalition.com/resources/resources.aspx>

Climate Change Considerations and Urban Forestry

Climate Change Tree Atlas (A Spatial Database of 134 Tree Species of the Eastern USA). This resource can be used to determine range shifts of tree species, namely in eastern states, as the climate changes. Species listed in city plans can be cross-checked with this resource to determine species that are resilient to both urban environments and climate change.

http://www.nrs.fs.fed.us/atlas/tree/tree_atlas.html#

⁴ Murphy, Susan. *Every Tree Counts In Fighting Climate Change, Says Ecologist*. 22 January 2013. KBPS, San Diego State University. URL: <http://www.kpbs.org/news/2013/jan/22/every-tree-counts-fighting-climate-change-says-eco/#.UQFOnAPqx0o.facebook> (accessed 1 May 2013).

For eastern half of the country, the climate change tree atlas can be used to determine shifts in species ranges as the climate changes. There is also a link to show tree “winners and losers” by state:

http://www.nrs.fs.fed.us/atlas/tree/mean_winlose_states.html

The US Forest Service and Oregon State University College of Forestry developed a Seedlot Selection Tool. Users select their region and a variety of climate variables, as well as future climate scenarios, to determine ranges of specific species or forest types. This tool may require a slight learning curve, but may give valuable information on species range shifts for future planning.

<http://sst.forestry.oregonstate.edu/index.html>

This simple map shows projected changes in average temperature and precipitation in the U.S. for the past 50 years, by mid century, and by the end of the century. This tool can be cross checked with species needs to determine if trees can survive under future projected conditions.

<http://www.climatewizard.org/>

As of spring 2013, the latest National Climate Assessment is under review to be released later this year. Previous assessments are available online, however, and offer insights into climate change and impacts on regional levels. Users can review key pieces of information, such as changes in precipitation and temperature, which can be used in the planning of urban forests.

<http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts>

NatureServe’s Climate Change Vulnerability Index is a tool that can be used to determine plant and animal species that are particularly vulnerable to the effects of climate change. This site contains the user guide and downloadable excel sheet, as well as training tools. In addition, the site gives examples of the index in use, including its application in Nevada, New York, Pennsylvania, and Illinois.

<http://www.natureserve.org/prodServices/climatechange/ccvi.jsp>

Resources for Species Selection

Plant Native allows users to input their state to see a short list of native trees and other plants in their area. The site offers basic information on the listed plants, such as drought tolerance and some benefits the plants provide. This list can be used as a starting place to identify native plants, and using other tools to determine their viability in a changing climate. <http://www.plantnative.org/rpl-ut.htm>

Many states have their own plant societies that offer resources and tips for determining the best plants to use in specific regions. Many, such as the Florida Native Plant Society, offer interactive maps to depict hardiness zones and the plants that can thrive there. <http://www.plantsocieties.org/#Affiliates>

The USDA plant hardiness zone map can be downloaded here at high resolutions, at the state, regional, or national scale. Many resources use this map to determine the best plants to use in a region. Most of these zones have shifted upwards since the first iteration of this map, and this trend is expected to continue. <http://planthardiness.ars.usda.gov/PHZMWeb/Maps.aspx>

The US Department of Agriculture has an extensive database of native and invasive plants. Users can input a specific species to determine its range and basic information on its habitat needs.

<http://plants.usda.gov/java/>

For more information on specific conifer and hardwood species, the U.S. Forest Service's Silvics of North America online atlas provides information on native ranges, past and current climate suitability, soils and topography, and life history.

http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm

Data Basin is a searchable online database that houses maps related to climate, protected areas, and global forests. Users can search for past and future climate projections, as well as ranges of native plants. This information can be helpful in determining species to plant in urban forests as climate changes. <http://databasin.org/>

The National Phenology Network's visualization tool allows users to input a single or multiple species to map their locations, phenology, and desired climate. This can help users understand the interaction between climate and specific species. <https://www.usanpn.org/node/6208>

Landscape For Life offers guides to citizens to garden in a sustainable way, based on their eco-region and other factors, such as density (eg., city vs. suburban gardens). Their website synthesizes a number of resources that can help the public and planners create natural areas that most benefit people and wildlife. <http://landscapeforlife.org>

Additional Resources

The UNH Stormwater Center (UNHSC) is dedicated to the protection of water resources through effective stormwater management.

<http://www.unh.edu/unhsc/>

Developed by the USDA Forest Service, iTree is a series of forestry analysis and benefits assessment tools that helps users quantify the ecosystem services and values from trees <http://itreetools.org/>

Alliance for Community Trees offers many resources related to urban forestry, including tree facts and guides, a list of contacts and resources for each state, and tools for nonprofits. <http://actrees.org/>

American Forests is a national nonprofit focused on issues related to forest conservation and restoration. Their site offers resources, contacts, and information related to many of their programs. Their Urban Forest section provides case studies and fact sheets on cities already successfully fostering their urban forests, many mentioned previously in this document. <http://www.americanforests.org/our-programs/urbanforests/>