OPEN SPACE AND AGRICULTURE

As the climate continues to change, in the next 30 years Columbia communities are likely to face vulnerabilities related to…

Trees and open space

LOW-MEDIUM

A warming climate and drought will stress trees, and provide more favorable conditions for disease, pests, and invasive vegetation that could be difficult to contain and manage. Existing habitats will be increasingly threatened under future conditions.

Agriculture

MEDIUM

Increasing drought, warmer temperatures, and changes in precipitation threaten the quality and quantity of crop yields and make crops more prone to pests and disease. However, technologies and innovation offer the potential for more resilient crops. Transitioning to different crops suitable to the new climate also remains a possibility.

Vulnerability Ranking

LOW | LOW-MEDIUM | MEDIUM | MEDIUM-HIGH | HIGH

Trees and open space

Across the City of Columbia, approximately 36% of land has tree canopy cover, according to the Urban Forest Master Plan [1]. A broad range of species is represented in this area, including upland species like oaks, maples, and hickory, and lowland species like sycamore and willow, as well as non-native and invasive species like elm [1].

Along Columbia's streets, the trees found in right-of-ways are considerably diverse, with the most common species being eastern redbud (8% of the inventoried population), ash varieties (12%), American sweetgum (4%) and sugar maple (3%) [1]. Nearly three-fourths of Columbia's street trees are in fair condition, meaning that additional stressors may worsen their conditions [1].

Columbia also has 3,375 acres of parks and green spaces and over 64 miles of trails in the community-wide system [2].

Average temperatures are expected to increase in Columbia as they will across the Midwest. By 2050, average temperatures will be 4°F higher or even warmer [3]. As temperatures warm, hardiness zones will change. Growers use hardiness zones (1 to 10), which are based on the average minimum temperature in the winter, to determine which plants are most suitable to the local climate. Columbia is currently in hardiness zone 6a (average annual minimum winter temperature of -10 to -5°F) [4]. Between 2000 and 2010, some parts of Missouri went up one hardiness zone level, and in the next 30 years, most of Missouri is projected to be in Zone 7 with an average minimum winter temperature of 1 to 10°F [5]. By 2070, hardiness zones may shift even more as minimum annual temperatures

in Missouri may increase by 7 to 11°F or more compared to the 1971-2000 average [6]. With these changes, some species of trees and shrubs may no longer be suitable to plant along Columbia's streets and in parks and open spaces, while some cold-intolerant species may become suitable. The net change in species suitability may impact the biodiversity of trees and shrubs—for better or for worse—compared to what Columbia's climate currently supports.

Columbia's urban landscape could potentially exacerbate the negative impacts from warmer temperatures. The urban heat island effect is the tendency for developed urban areas to be hotter than surrounding rural areas because roads, buildings, and other dry impermeable surfaces have replaced open land and vegetation. Across the U.S., the urban heat island effect has led to an average increase in urban temperatures of 5.2°F [7]. There is some indication that the urban heat island effect may be occurring in Columbia as well [8]. In a warming climate, resources may be needed to plant more trees as well as maintain current trees to help mitigate the urban heat island effect.

Periods of extreme heat and summertime drought are expected to become more common in Missouri, which will make it more difficult to establish new plantings and may reduce survival rates. Columbia experienced the impact of drought in 2012 when some trees died due to low soil moisture and high soil temperatures [9]. More staff time and resources will be needed to water and maintain new plantings, add more mulch to surround trees, and replace plantings if they do not survive. These impacts will likely increase maintenance and operational costs. Species that are more tolerant to dry conditions—including hawthorn, swamp white oak, Kentucky coffee tree, and eastern red cedar—may fare better [10].

Plants and trees are more susceptible to disease and insects—such as oak wilt and the non-native, invasive Emerald Ash Borer—as a result of warming temperatures and drought, which stress them [11]. Thousand cankers disease, which is lethal to black walnut trees, is also of concern for potentially causing economic losses, but it has not yet been observed in Missouri [12]. Oak wilt is a lethal fungal disease that especially affects red oak species and has been observed in Boone County in recent years [11].

Invasive species that have been observed in Columbia's parks and public right-of-ways are listed below.

Species of significant concern:

- Bush honeysuckles
- Callery or Bradford pear
- Common and cut-leaved teasel
- Japanese honeysuckle
- Japanese hops
- Japanese knotweed
- Johnson grass
- Reed canary grass
- Sericea lespedeza
- Wintercreeper

Other species:

- Autumn olive
- Black locust
- Burning bush
- Crown vetch
- Multiflora rose
- Musk thistle

While Emerald Ash Borer has not yet been observed in Columbia, infestations have been confirmed in counties just to the south of Boone County, making it likely that Emerald Ash Borer will spread to Columbia in the coming years [13]. In a warming climate, fewer instances of extremely low temperatures will likely allow Emerald Ash Borer populations to grow and spread. On the other hand, with more extreme weather, this insect may be less able to withstand cold snaps when they do occur [14]. In addition, once average highs exceed the current range that Emerald Ash Borer populations require to survive, these warm temperatures may limit their spread and survival [15]. In 2014, the City of Columbia leveraged a Tree Resource Improvement and Maintenance (TRIM) grant from the Missouri Department of Conservation to inventory ash trees in public spaces and develop an Emerald Ash Borer management plan in preparation for a potential infestation [16]. In addition, the City Parks Department is updating its inventory of ash trees in city parks. The statewide Emerald Ash Borer Action Plan represents another source of support to aid Columbia in preventing and preparing for Emerald Ash Borer [17].

Meanwhile, increased stress and potential loss of vegetation creates more opportunities for non-native and invasive plants to become established, and invasive plants may be able to adapt to new conditions faster than native plants can [18]. Even though native plants and ecosystems have adapted to changing climates in the past, the rate at which the climate is currently changing is projected to be faster than the historical rate at which these plants can adapt. The habitat quality of Columbia's natural areas, riparian corridors, and right-of-ways has already been compromised by invasive vegetation and has hindered the City's ability to manage these areas; climate change impacts will likely exacerbate these issues. These areas will require active management to build more biodiverse and resilient vegetation and wildlife communities that are able to withstand climate change impacts and outcompete invasive species.

Climate change also presents some opportunities, such as a longer planting window and a longer growing season, but more extreme conditions may counteract these possible benefits.

Community action to remove invasive bush honeysuckle

In 2016, members of the East Campus Neighborhood Association came together to remove invasive bush honeysuckle from their neighborhood. Bush honeysuckle interrupts the function of our natural ecosystems by outcompeting native vegetation, reducing biodiversity, and preventing forest regeneration. These impacts are exaggerated by climate change and will likely result in a less resilient community.

The group of thirty neighbors worked together to remove as much bush honeysuckle from their yards as possible. The only existing bush honeysuckle in the neighborhood was found along steep hillsides. The neighborhood partnered with the Missouri Department of Conservation on a wildlife diversity grant that awarded $11,000 to hire a forestry consultant to remove and treat the remaining bush honeysuckle. This type of partnership with the conservation department is unprecedented and exemplifies Columbians' enthusiasm for being good stewards of our land, water, and wildlife resources.

Agriculture

On the 1,171 farms in Boone County in 2012, farmers most commonly grew soybeans, hay and other forage, corn, and winter wheat, and raised cattle and pigs, among other livestock [19]. The average farm had $44,564 in sales that year [19]. In total, agriculture, forestry, and related industries contributed $1 billion in sales to Boone County's economy in 2016 and represented over 6% of jobs [20].

As the climate changes, temperatures will increase in Columbia and change frost timing. It is projected that the last spring frost will happen one week earlier by 2050 than it does today, and the first fall frost will be slightly later [8]. Under these conditions, the timing of the growing season may shift and hardiness zones will continue to change. Farmers may have to adjust planting schedules and change or diversify crop types to adapt to these changes.

Warmer temperatures, especially during the summer, will likely place more stress on livestock and crops. Cows, for instance, tend to eat less food and grow more slowly in hotter conditions, and corn yields are projected to decrease with warmer summers [21]. Although longer growing seasons, combined with more carbon dioxide in the atmosphere—which acts as a fertilizer for plants—could increase yields of some crops, long-term agricultural productivity is expected to decline as the cumulative negative impacts of climate change offset these short-term benefits [22].

Ozone smog may increase with warmer air temperatures, and high ozone levels can slow plant growth and reduce yields of soybean and winter wheat. In some areas of Missouri, ozone levels have been high enough to potentially reduce crop yields [21]. High ozone levels can also harm lung and heart health. In Boone County, there were 13 days between 2012 and 2014 when air quality was considered unhealthy for sensitive populations such as older adults, children, and people with respiratory disease [23]. Farmworkers may be more exposed to ozone smog because of the time spent outdoors.

Increasing summer drought could stress crops and lower the quality and quantity of yields. Farms growing corn may be more vulnerable to drought than soybean and wheat farms, but using drought-tolerant varieties can increase resilience to these conditions [24]. Drier conditions in the summer are expected to reduce soil moisture, which could lower agricultural productivity and increase the demand for irrigation [25]. The availability of water resources for irrigation may become a concern in the future as Columbia's population grows, especially if there are periods of prolonged drought.

Spring and fall precipitation is projected to increase in Columbia [8]. For agriculture, heavier rains during the spring can disrupt planting schedules, make it difficult for crops to become

established, and make diseases from fungus or bacteria more likely to occur. Addressing these impacts may require more labor and increase costs to farms.

All of these impacts from climate change can place more stress on crops, making them **more susceptible to pests and diseases**. Recent testing submissions to the University of Missouri's Plant Diagnostic Clinic suggest that corn, soybean, and wheat are all susceptible to disease, but disease prevalence may fluctuate from year to year and throughout a single growing season as environmental conditions change [26]. The Japanese beetle is one pest of concern. Even the potential benefit of larger yields from higher levels of carbon dioxide may be offset, as these conditions can lower plants' defenses against Japanese beetle and other insects, ultimately causing more damage than under current climate conditions [27]. Meanwhile, warmer temperatures and increased carbon dioxide may cause insect populations to grow and new types of pests to become problematic. Japanese beetles in particular may be more likely to survive and cause more damage to soybean yields as the optimal time period for feeding on leaves is projected to increase nearly threefold by 2050 [28].

Growers will likely need to plant drought- and pest-resistant crop varieties, implement water conservation measures, use more efficient irrigation strategies, or take other actions to adapt to future conditions. Those with limited resources may need financial assistance to continue their agricultural livelihoods. As climate change impacts may reduce crop yields, farmers in Columbia may face economic challenges. In addition, food production in Missouri, across the U.S., and beyond may decrease, leading to increases in food costs for the Columbia community.

Urban agriculture

In a city like Columbia, the abundance of people and access to irrigation create an opportunity for fruit and vegetable production. Small acreages managed with intensive practices can yield an extremely high volume (and value) of agricultural products [29]. The potential for well-organized agricultural practices to produce a significant amount of a city and a region's food supply has proven by "The Intervale," a 350-acre farm in Vermont that has helped to build a wide network of growers, distributers, and eaters in that region. Many labor-intensive crops are particularly well-suited for an urban production setting.

Backyard gardens and community gardens provide a distributed production model that engages a lot of people. The benefits include not only the direct yields from the gardens, but also a range of secondary benefits such as outdoor education, beginning farmer training, community safety via passive neighborhood watch, pollinator biodiversity, soil health/water holding capacity, and much more. Collaboration on urban gardens can build social cohesion, which enhances community resilience to climate change and other stressors.

The Columbia Center for Urban Agriculture, Community Garden Coalition, Grow Well Missouri, Columbia Farmers Market, and others are working on many urban agriculture and farmer projects like those mentioned above. One specific example is the Agriculture Park; phase one construction is scheduled for 2018. This project has the potential to bring together many of the stakeholders in the farming, food service, education, health care, and civic sectors.

Urban gardens will need to be ready for the climate change impacts that will face all local agriculture, and look for ways to use water efficiently, but they can also enhance food security and contribute to climate resilience in other ways.

Native roadside vegetation

The Public Works Department has partnered with the Sustainability Office to begin converting non-native right-of-way vegetation to native plants. These sites consist of green space in roundabouts, medians, and along our roads. Native habitat patches, oftentimes consisting of glade- or prairie-adapted wildflowers and grasses, typically require mowing only once per year once established, while non-native vegetation needs regular mowing, weed-eating, and blowing. Less maintenance with motorized equipment reduces the carbon emissions generated from these activities. Vegetation along roundabouts and along our roads also helps to manage stormwater, which will be important as heavy rain events happen more often.

Thus far, Public Works has converted several sites to native vegetation and is measuring the effectiveness of this strategy to conserve resources and provide habitat, with the technical and logistical assistance of the Sustainability Office. Public Works has also hired staff to map and assess all other public right-of-way property to determine the number of acres suitable for conversion. In conjunction with this effort, Public Works staff are developing an integrated vegetation management plan (IVMP) that will guide Public Works to manage noxious weeds and invasive vegetation in these areas as well as to support biodiverse habitat patches to benefit wildlife, such as monarch butterfly and native bee populations that have faced severe declines in recent years.

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