CLIMATE IMPACTS – MIDWEST

From the Adaptation Workbook: www.adaptationworkbook.org/explore-impacts

This region was defined in the National Climate Assessment (2014) and includes the states of Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin. For additional details, see: National Climate Assessment (2018) - Midwest

Summary of Climate Impacts (details and citations on subsequent pages):

Temperatures in the Midwest are projected to increase by 4.5 to 9.5 degrees Fahrenheit by 2085.

The Midwest is expected to experience between 5 and 30 more days per year with a maximum temperature exceeding 95 degrees Fahrenheit by the middle of the century.

The Midwest is expected to experience between 0 and 25 fewer days per year with a minimum temperature below 10 degrees Fahrenheit by the middle of the century.

Climate conditions will increase fire risks in in the Midwest by the end of the century.

Average annual precipitation is projected to increase slightly in northern portion of the Midwest, but may decrease in the southern half of the region.

The number of days per year with more than 1 inch of precipitation will increase across the Midwest by the middle of the century.

A majority of climate models suggest that precipitation in the Midwest will increase in the winter, spring, and fall by the end of the century, but summer projections are more uncertain.

The annual freeze-free season is expected to increase by 18 to 26 days in the Midwest by 2055.

Climate change will amplify many existing stressors to forest ecosystems in the Midwest, such as invasive species, insect pests and pathogens, and disturbance regimes.

Boreal and northern tree species in the Midwest are generally expected to decline in suitable habitat under climate change, while temperate tree species, grasslands, savannas, and woodlands may expand by the end of the century.

Low-diversity systems are at greater risk from climate change.

Systems that are more tolerant of disturbance have less risk of declining on the landscape

Species in fragmented landscapes will have less opportunity to migrate in response to climate change.

Systems that are limited to particular environments will have less opportunity to migrate in response to climate change.

Temperatures in the Midwest are projected to increase by 4.5 to 9.5 degrees Fahrenheit by 2085.

All climate models agree that temperatures are projected to increase over the 21st century across the Midwest. The greatest warming during the winter is expected in northwestern Minnesota, while the greatest warming during the summer is expected in southern portions of the Midwest.

K. Kunkel, L. Stevens, and others. 2013. Regional climate trends and scenarios for the U.S. National Climate Assessment: Climate of the Midwest U.S.

The Midwest is expected to experience between 5 and 30 more days per year with a maximum temperature exceeding 95 degrees Fahrenheit by the middle of the century.

The smallest increases of 5 days per year is expected in areas with a currently low number of 95-degree days, including the northern parts of states bordering Canada, where the general increase in temperature in not large enough to substantially increse the occurences of such warm days. The largest increase in the number of 95-degree days per year is expected in the southern portion of the Midwest, where these kinds of hot days are already common. Similarly, most of the Midwest is expected to experience more 0-

12 more consecutive 95-degree days by the middle of the century, with as many as 20 additional consecutive days in southern Missouri.

K. Kunkel, L. Stevens, and others. 2013. Regional climate trends and scenarios for the U.S. National Climate Assessment: Climate of the Midwest U.S.

The Midwest is expected to experience between 0 and 25 fewer days per year with a minimum temperature below 10 degrees Fahrenheit by the middle of the century.

The largest decreases are expected in Minnesota, Wisconsin, and northern Michigan. The smallest decreases in cold days are expected in southern Missouri, Illinois, Indiana, and Ohio, where these kinds of cold days rarely occur. Similarly, the Midwest region is expected to have 18 to 25 fewer days with a minimum temperature below 32 degrees by the middle of the century.

K. Kunkel, L. Stevens, and others. 2013. Regional climate trends and scenarios for the U.S. National Climate Assessment: Climate of the Midwest U.S.

Climate conditions will increase fire risks in in the Midwest by the end of the century.

Different modeling approaches generally conclude that future climate conditions will increase the risk of wildfire across the Midwest. Annual fire probability, calculated solely with climate data and physical principles, is projected to increase by 20% to 80% across the Midwest by the end of the century. The incidence of atmospheric conditions that contribute to large and erratic fire behavior, measured by the Haines Index, is also projected to occur more frequently by the end of the century. The limitation for these sorts of projections is that they do not account for changes in land use, fire suppression rates, or vegetation changes.

Y. Tang, S. Zhong, and others. 2015. The Potential Impact of Regional Climate Change on Fire Weather in the United States. Annals of the Association of American Geographers.

R. Guyette, F. Thompson, and others. 2014. Future Fire Probability Modeling with Climate Change Data and Physical Chemistry. Forest Science.

Average annual precipitation is projected to increase slightly in northern portion of the Midwest, but may decrease in the southern half of the region.

There is uncertainty between different climate scenarios for future precipitation projections in the Midwest. Generally, there is a south-to-north gradient in annual precipitation projections, with increases projected north of the Iowa-Missouri border and little change or slight decreases projected in the south.

K. Kunkel, L. Stevens, and others. 2013. Regional climate trends and scenarios for the U.S. National Climate Assessment: Climate of the Midwest U.S.

The number of days per year with more than 1 inch of precipitation will increase across the Midwest by the middle of the century.

Most of the region is projected to experience 10% to 30% more days each year with more than an inch of precipitation by the middle of the century. The largest increases (up to 60% increases) in extreme precipitation are expected in northern states. Days with more than 2 inches, 3 inches, and 4 inches of precipitation are also expected to occur more regularly by the middle of the century.

K. Kunkel, L. Stevens, and others. 2013. Regional climate trends and scenarios for the U.S. National Climate Assessment: Climate of the Midwest U.S.

A majority of climate models suggest that precipitation in the Midwest will increase in the winter, spring, and fall by the end of the century, but summer projections are more uncertain.

Simulated changes in summer precipitation by the end of the century range from a 36-percent decrease to a 24-percent increase, with a mean around an 8% decrease. The means of several climate models indicate that winter and spring precipitation may increase around 10% by the end of the century, while fall precipitation may increase only slightly. Under mild climate scenarios, changes are generally smaller than in more extreme climate scenarios.

K. Kunkel, L. Stevens, and others. 2013. Regional climate trends and scenarios for the U.S. National Climate Assessment: Climate of the Midwest U.S.

The annual freeze-free season is expected to increase by 18 to 26 days in the Midwest by 2055.

The freeze-free season is defined as the period of time between the last spring frost (daily minimum temperature below 32 degrees F) and the first fall frost. The length of the annual freeze-free season has been increasing since the 1980s, and all climate models agree that it will continue to increase in the future.

K. Kunkel, L. Stevens, and others. 2013. Regional climate trends and scenarios for the U.S. National Climate Assessment: Climate of the Midwest U.S.

Climate change will amplify many existing stressors to forest ecosystems in the Midwest, such as invasive species, insect pests and pathogens, and disturbance regimes.

Forest ecosystems throughout the Midwest Region are exposed to a range of natural, introduced, and anthropogenic stressors. Stressors such as invasive plants, forest pests, diseases, droughts, and floods are expected to become more damaging under climate change, and these factors may interact in unpredictable ways.

S. Handler, C. Swanston, and others. 2014. Climate change vulnerabilities within the forestry sector for the Midwestern United States. Island Press.

Boreal and northern tree species in the Midwest are generally expected to decline in suitable habitat under climate change, while temperate tree species, grasslands, savannas, and woodlands may expand by the end of the century.

When considering the potential for ecosystem conversions, species migration is a critical issue. It is not necessarily communities that move, but instead species that move and then form new communities. Species distribution models have also indicated that species may respond individually to future climate change, with suitable habitat expanding for some species and declining for others.

S. Handler, C. Swanston, and others. 2014. Climate change vulnerabilities within the forestry sector for the Midwestern United States. Island Press.
Landscape Change Research Group. 2014. Climate Change Atlas. USDA Forest Service Northern Research Station.

Low-diversity systems are at greater risk from climate change.

Studies have consistently shown that diverse systems have exhibited greater resilience to extreme environmental conditions and greater potential to recover from disturbance than less diverse communities. This relationship makes less diverse communities inherently more susceptible to future changes and stressors. The diversity of potential responses of a system to environmental change (response diversity), is a critical component of ecosystem resilience. Response diversity is generally reduced in less diverse ecological systems. Genetic diversity within species is also critical for the ability of populations to adapt to climate change, because species with high genetic variation have better odds of producing individuals that can withstand extreme events and adapt to changes over time.

T. Elmqvist, C. Folke, and others. 2003. Response diversity, ecosystem change, and resilience. Frontiers in Ecology and the Environment.
A. Hoffman and C. Sgrò. 2011. Climate change and evolutionary adaptation. Nature.

Systems that are more tolerant of disturbance have less risk of declining on the landscape

Disturbances such as wildfire, flooding, and pest outbreaks are expected to increase in the future. Forests that are adapted to gap-phase disturbances, with stand-replacing events occurring over hundreds or thousands of years, may be less tolerant of more frequent widespread disturbances. Mesic hardwood forests can create conditions that could buffer against fire and drought to some extent, but these systems are not expected to do well if soil moisture declines significantly. Forest systems that are more tolerant of drought, flooding, or fire are expected to be better able to withstand climate-driven disturbances. This principle holds true only to a given point, because it is also possible for disturbance-adapted systems to experience too much disruption. For example, dry pine forests and woodlands might benefit from drier conditions with more frequent fire, but these systems might also convert to savannas or open grasslands if fire becomes too frequent or drought becomes too severe.

G. Nowacki and M. Abrams. 2008. The Demise of Fire and "Mesophication" of Forests in the Eastern United States. BioScience.
E. Gustafson and B. Sturtevant. 2013. Modeling Forest Mortality Caused by Drought Stress: Implications for Climate Change. Ecosystems.

Species in fragmented landscapes will have less opportunity to migrate in response to climate change.

Habitat fragmentation can hinder the ability of tree species to migrate to more suitable habitat on the landscape, especially if the surrounding area is nonforested. Modeling results indicate that mean centers of suitable habitat for tree species will migrate between 60 and 350 miles by the year 2100 under a high emissions scenario and between 30 and 250 miles under milder climate change scenarios. Based on data gathered for seedling distributions, it has been estimated that many northern tree species could possibly migrate northward at a rate of 60 miles per century. Fragmentation makes this disparity even more challenging, because the landscape is essentially less permeable to migration.

L. Iverson, M. Schwartz, and others. 2004. How fast and far might tree species migrate in the eastern United States due to climate change? Global Ecology and Biogeography.

C. Woodall, C. Oswalt, and others. 2009. An indicator of tree migration in forests of the eastern United States. Forest Ecology and Management.

Systems that are limited to particular environments will have less opportunity to migrate in response to climate change.

Some species and forest types are confined to particular habitats on the landscape, whether through requirements for hydrologic regimes, soil types, or other reasons. Similar to species occurring in fragmented landscapes, isolated species and systems face additional barriers to migration. Widespread species may also have particular habitat requirements. For example, sugar maple is often limited to soils that are rich in nutrients like calcium, so this species may actually have less available suitable habitat than might be projected solely from temperature and precipitation patterns. Riparian forests are not expected to be able to migrate to upland areas because many species depend on seasonal flood dynamics for regeneration and a competitive advantage. Similarly, lowland conifer swamps contain a unique mix of species that are adapted to low pH values, peat soils, and particular water table regimes. These species face additional challenges in migration compared to more-widespread species with broad ecological tolerances.

A. Jump and J. Peñuelas. 2005. Running to stand still: adaptation and the response of plants to rapid climate change. Ecology Letters.