CLIMATE IMPACTS – NEW ENGLAND AND NORTHERN NEW YORK

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

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

Temperatures in New England are projected to increase 3.5 to 8.5 °F by the end of the century, with the greatest warming expected to occur during winter.

The growing season in New England and northern New York is generally expected to increase by 20 days or more by the end of the century, due to fewer days with a minimum temperatures below 32°F.

The winter season will be shorter and milder across New England and northern New York, with less precipitation falling as snow and reduced snow cover and depth.

Sea levels along the Atlantic coast in New England are expected to rise by 7 to 23 inches by the end of the century.

Precipitation patterns will be altered, with projected increases in annual precipitation and potential for reduced growing season precipitation in New England and northern New York.

Intense precipitation events will continue to become more frequent in New England and northern New York.

The timing and amount of stream flow is expected to change over then next century across New England and northern New York.

Warmer temperatures and altered precipitation in New England and northern New York will interact to change soil moisture patterns throughout the year, with the potential for both wetter and drier conditions depending on the location and season.

Forest vegetation in New England and northern New York may face increased risk of moisture deficit and drought during the growing season.

Certain insect pests and pathogens will increase in occurrence or become more damaging in New England and northern New York.

Many invasive plants will increase in extent or abundance in New England and northern New York.

Many northern and boreal tree species will face increasing stress across much of New England and northern New York.

Habitat will become more suitable in New England and northern New York for some southern species.

Forest composition will change across the landscape in New England and northern New York.

Shifts in forest composition in New England and northern New York will take at least several decades to occur in the absence of major disturbance.

Conditions affecting tree regeneration and recruitment will change in New England and northern New York.

Forest productivity in New England and northern New York will increase during the next several decades in the absence of significant stressors.

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

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.

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

New England and northern New York forest ecosystem vulnerability assessment and synthesis

Video presentation: Climate Change Impacts for New England Forests

See forest type vulnerability on next page.

Table 14.—Summary of vulnerability determination for the forest systems considered in this assessment evaluated through the end of the 21st century

Forest system	Potential impacts	Adaptive capacity	Vulnerability	Evidence	Agreement
Central hardwood-pine	Neutral-Positive	Moderate-High	Low	Medium	Medium-High
Low-elevation spruce-fir	Neutral-Negative	Moderate	Moderate-High	Medium	Medium
Lowland and riparian hardwood	Positive and Negative	Moderate-High	Moderate	Limited	Limited
Lowland mixed conifer	Neutral-Negative	Low-Moderate	Moderate-High	Limited-Medium	Medium
Montane spruce-fir	Neutral-Negative	Moderate	Moderate-High	Medium	Medium
Northern hardwood	Positive and Negative	Moderate-High	Low-Moderate	Medium	Medium
Pitch pine-scrub oak	Neutral-Positive	Moderate	Low	Medium	Medium
Transition hardwood	Positive and Negative	Moderate-High	Low-Moderate	Medium	Medium-High

Table source: M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

Temperatures in New England are projected to increase 3.5 to 8.5 °F by the end of the century, with the greatest warming expected to occur during winter.

All global climate models project that temperatures in New England and northern New York will increase over the next century as a result of continued increases in atmospheric greenhouse gas concentrations.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

D. Lorenz and M. Notaro. 2014. LCC Statistical Downscaling. Nelson Center for Climatic Research - University of Wisconsin-Madison.

C. Lynch, A. Seth, and others. 2016. Recent and Projected Annual Cycles of Temperature and Precipitation in the Northeast United States from CMIP5. Journal of Climate.

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

The growing season in New England and northern New York is generally expected to increase by 20 days or more by the end of the century, due to fewer days with a minimum temperatures below 32°F.

Evidence at both global and local scales indicates that growing seasons have been getting longer, and this trend is projected to become even more pronounced over the next century. Warmer temperatures will result in fewer days with minimum temperatures below 32°F and a shorter freeze-free season.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

D. Lorenz and M. Notaro. 2014. LCC Statistical Downscaling. Nelson Center for Climatic Research - University of Wisconsin-Madison.

C. Lynch, A. Seth, and others. 2016. Recent and Projected Annual Cycles of Temperature and Precipitation in the Northeast United States from CMIP5. Journal of Climate.

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

The winter season will be shorter and milder across New England and northern New York, with less precipitation falling as snow and reduced snow cover and depth.

A variety of models project that winters will become more mild across New England and northern New York as temperatures increase. Warmer temperatures will cause more winter precipitation to be delivered as rain. Snowfall, snow depth, and snow pack duration are all expected to be reduced.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

M. Notaro, D. Lorenz, and others. 2014. 21st century projections of snowfall and winter severity across central-eastern North America. Journal of Climate.

D. Lorenz and M. Notaro. 2014. LCC Statistical Downscaling. Nelson Center for Climatic Research - University of Wisconsin-Madison.

Sea levels along the Atlantic coast in New England are expected to rise by 7 to 23 inches by the end of the century.

All global climate models agree that sea level will rise over the next century. Sea levels have risen over the past century, and this trend is expected to continue. At the current rate of increase, sea levels could rise nearly 6 inches by the end of the century across the Northeast, which is a conservative estimate. Additional warming is expected to increase sea levels in the Northeast by 7 to 23 inches by the end of the century.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

W. Sweet, R. Kopp, and others. 2017. Global and Regional Sea Level Rise Scenarios for the United States. NOAA Technical Report.

Precipitation patterns will be altered, with projected increases in annual precipitation and potential for reduced growing season precipitation in New England and northern New York.

All global climate models agree that there will be changes in precipitation patterns across the assessment area, but there is large variability among projections of future precipitation. Most climate models project increases in annual precipitation. Seasonally, winter and spring are also generally projected to have increases in precipitation during the next century. Projections of summer and fall precipitation vary more widely, with many models projecting decreased precipitation or only very slight increases.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

D. Lorenz and M. Notaro. 2014. LCC Statistical Downscaling. Nelson Center for Climatic Research - University of Wisconsin-Madison.

C. Lynch, A. Seth, and others. 2016. Recent and Projected Annual Cycles of Temperature and Precipitation in the Northeast United States from CMIP5. Journal of Climate.

Intense precipitation events will continue to become more frequent in New England and northern New York.

Heavy precipitation events have increased substantially in number and severity in the across the Northeast over the last century, and many models agree that this trend will continue over the next century. Extreme precipitation events could lead to more frequent or severe flooding and an increase in soil erosion.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

D. Lorenz and M. Notaro. 2014. LCC Statistical Downscaling. Nelson Center for Climatic Research - University of Wisconsin-Madison.

L. Ning, E.E. Riddle, and others. 2015. Journal of Climate.

The timing and amount of stream flow is expected to change over then next century across New England and northern New York.

The shifts in winter precipitation and temperature described above are expected to alter several hydrological variables. Warmer temperatures are expected to accelerate the hydrologic cycle by reducing winter snow cover and shifting an increasing amount of runoff to winter and away from spring and summer. Researchers project that peak (winter/spring) streamflow may advance by 10 to greater than 15 days by the end of the century, with the greater shifts in the north due to the influence of snowmelt on streamflow. Similarly, low streamflows are generally projected to be lower, particularly during the fall and under scenarios projecting greater warming. Additionally, there is expected to be greater annual variation, with increases in both low- and high-flow events through the course of the year.

M. Janowiak, A. D'Amato, and others. 2018. [New England and New York forest ecosystem vulnerability assessment and synthesis](). US Forest Service Northern Research Station.
L. Rustad, J. Campbell, and others. 2012. [Changing climate, changing forests: Impacts of climate change on forests of the northeastern United States and eastern Canada](). USDA Forest Service Northern Research Station.
T. Huntington, D. Richardson, and others. 2009. [Climate and hydrological changes in the northeastern United States](). Canadian Journal of Forest Research.

Warmer temperatures and altered precipitation in New England and northern New York will interact to change soil moisture patterns throughout the year, with the potential for both wetter and drier conditions depending on the location and season.

Soil moisture is expected to change in response to warmer temperatures and seasonal changes in precipitation. Changes are likely to vary seasonally as well as geographically. More intense and prolonged precipitation events would be expected to create wetter soil conditions, while increased temperatures and less frequent rainfall events would lead to drier soils . Wetter conditions may become for frequent during much of the year, but increased evapotranspiration associated with warmer temperatures and longer rain-free periods between large precipitation events may lead to drier soils during the growing season. Locations where soils and landforms cannot retain the water from intense precipitation events may be more likely to have drier conditions during the growing season.

M. Janowiak, A. D'Amato, and others. 2018. [New England and New York forest ecosystem vulnerability assessment and synthesis](). US Forest Service Northern Research Station.
K. Hayhoe, C. Wake, and others. 2006. [Past and future changes in climate and hydrological indicators in the US Northeast](). Climate Dynamics.

Forest vegetation in New England and northern New York may face increased risk of moisture deficit and drought during the growing season.

The uncertainty of future precipitation patterns makes it difficult to determine whether conditions may become dry enough to increase moisture stress for plants in the Northeast. Forests that are affected by moisture deficits and drought are more likely to experience reduced tree vigor or increased mortality, both of which can affect forest composition and structure. Further, warmer temperatures can drive or enhance drought-induced mortality by disrupting plant physiology . This “hotter drought” can also interact with other forest stressors to cause tree death and forest die-off .

M. Janowiak, A. D'Amato, and others. 2018. [New England and New York forest ecosystem vulnerability assessment and synthesis](). US Forest Service Northern Research Station.
K. Hayhoe, C. Wake, and others. 2006. [Past and future changes in climate and hydrological indicators in the US Northeast](). Climate Dynamics.

Certain insect pests and pathogens will increase in occurrence or become more damaging in New England and northern New York.

The loss of a traditionally cold climate and short growing season in the region may allow some insect pests and pathogens to expand their ranges northward such as hemlock woolly adelgid and southern pine beetle. Forest impacts from insect pests and pathogens are generally more severe in ecosystems that are stressed by drought and other stressors. Basic information is often lacking on the climatic thresholds that trigger increased populations of many forest pests, and our ability to predict the mechanisms of infection, dispersal, and transmission for disease agents remains low. Further, it is not possible to predict which new pests or pathogens will enter the region during the 21st century.

M. Janowiak, A. D'Amato, and others. 2018. [New England and New York forest ecosystem vulnerability assessment and synthesis](). US Forest Service Northern Research Station.
J. Dukes, J. Pontius, and others. 2009. [Responses of insect pests, pathogens, and invasive plant species to climate change in the forests of northeastern North America](). Canadian Journal of Forest Research.

Many invasive plants will increase in extent or abundance in New England and northern New York.

Many invasive species that currently threaten regional forests may benefit directly from projected climate change or benefit from the relatively slower adaptation response of native species. Increases in carbon dioxide increase growth for many plant species, andcChanges in climate may have allowed some invasive plant species to expand their ranges northward, including bush honeysuckle, privet, and kudzu. Some invasive species are tolerant of drought, fire, flooding, and other disturbances and may be at an even greater advantage under future climate conditions. A lack of information regarding the climatic thresholds for many invasive plants limits the ability to predict future spread. Additionally, it is not possible to predict all future nonnative plant species that may enter the assessment area during the 21st century.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

L. Rustad, J. Campbell, and others. 2012. Changing climate, changing forests: Impacts of climate change on forests of the northeastern United States and eastern Canada. USDA Forest Service Northern Research Station.

Many northern and boreal tree species will face increasing stress across much of New England and northern New York.

Across northern latitudes, warmer temperatures are expected to be more favorable to individuals near the northern extent of their species' range and less favorable to those near the southern extent. Results from climate impact models project a decline in suitable habitat and landscape-level biomass for northern species such as black spruce, red spruce, tamarack, and paper birch, as well as spruce-fir forest communities. These northern species may persist in the region throughout the 21st century, although with declining vigor. Boreal species may remain in areas with favorable soils, management, or landscape features. For example, climate refugia at high elevations or in other favorable microclimates may be buffered from some changes.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

L. Rustad, J. Campbell, and others. 2012. Changing climate, changing forests: Impacts of climate change on forests of the northeastern United States and eastern Canada. USDA Forest Service Northern Research Station.

Landscape Change Research Group. 2014. Climate Change Atlas. USDA Forest Service Northern Research Station.

Habitat will become more suitable in New England and northern New York for some southern species.

Model results project that species currently near their northern range limits in the region may become more abundant and more widespread under a range of climate futures. Results from forest impact models suggest that species such as black cherry, chestnut oak, and yellow-poplar may have increases in both suitable habitat and biomass, and some deciduous forest types have the potential for productivity increases across the assessment area. It is important to note that forest communities will not be influenced only by shifts in habitat ranges, but also by species' ability to actually migrate and establish in new areas. Additionally, warmer climates are also likely to allow for range expansions and increased impacts from a variety of biological stressors, including insect pests, forest diseases, and invasive plant species.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

Landscape Change Research Group. 2014. Climate Change Atlas. USDA Forest Service Northern Research Station.

Forest composition will change across the landscape in New England and northern New York.

Changes in distribution for individual species is expected to lead to shifts in forest assemblages and tree species may rearrange into novel communities.Major shifts in overstory species composition may not be observable until well into the 21st century because of the long time frames associated with many ecosystem processes and responses to climate change. These shifts, however, may become more apparent along ecotones where boreal species reach the southern edge of their range. Major stand-replacing disturbance events, forest management, and human activities all have the potential to strongly influence how forests change in response to changing climatic conditions. Additionally, non-native species may also be to take advantage of shifting forest communities and unoccupied niches if native forest species are limited.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

Shifts in forest composition in New England and northern New York will take at least several decades to occur in the absence of major disturbance.

Model projections that show future changes in habitat for many tree species do not account for migration constraints, longevity of current species, or differences among age classes. Because mature trees are expected to remain on the landscape, and recruitment of new species is expected to be limited, major shifts in species composition will not likely be observed by the middle of the century, except along ecoregional boundaries and in areas that undergo major stand-replacing disturbance events. However, climate change is may increase the intensity, scope, or frequency of some stand-replacing events such as windstorms, ice storms, and insect outbreaks, possibly promoting rapid shifts in species composition where these events occur.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

Conditions affecting tree regeneration and recruitment will change in New England and northern New York.

Climate change impacts are more likely to be observed in seedlings and early growth than in mature trees. Temperature and moisture requirements for seed dormancy and germination are often much more critical than habitat requirements of an adult tree. Predicted changes in temperature, precipitation, growing season onset, and soil moisture may alter the duration or manifestation of germination conditions, and individual species will be uniquely affected. For species with high dispersal capabilities, these changes may result in redistribution on the landscape as seeds germinate only where conditions are met. Other species may fail to regenerate under altered future conditions, or may germinate without having optimal conditions for development. After establishment, saplings are still more sensitive than mature trees to disturbances such as drought, heat stress, fire, flooding, and herbivory. Changes in tree regeneration and recruitment will have long-term effects on forest composition and structure.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US Forest Service Northern Research Station.

Forest productivity in New England and northern New York will increase during the next several decades in the absence of significant stressors.

Model projections that show future changes in habitat for many tree species do not account for migration constraints, longevity of current species, or differences among age classes. Because mature trees are expected to remain on the landscape, and recruitment of new species is expected to be limited, major shifts in species composition will not likely be observed by the middle of the century, except along ecotonal boundaries and in areas that undergo major stand-replacing disturbance events. However, climate change is may increase the intensity, scope, or frequency of some stand-replacing events such as windstorms, ice storms, and insect outbreaks, possibly promoting rapid shifts in species composition where these events occur.

M. Janowiak, A. D'Amato, and others. 2018. New England and New York forest ecosystem vulnerability assessment and synthesis. US 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.

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.

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.