Forest landowners are seeing increased pressure from threats like fire, insects, disease, extreme weather, and drought on their land and resources. The last decade has brought record droughts to North Carolina, increasing wildfires, expanding insect and plant invasions, and more intense hurricane and tornado events. Scientists predict increases in temperature and changes in rainfall patterns that can make these threats occur more often, with more intensity, and/or for longer durations. However, there are forest management strategies that can be used to decrease the risk from these threats.

WHY DOES IT MATTER TO ME ?

It is important for private forest landowners to prepare for the likelihood of increasing threats when managing your land. Private forests make up the largest holdings of forestlands in the southeastern U.S. These properties collectively will be crucial in protecting the overall health of our landscape. Management that takes the most current science into account will enable landowners to better protect your land and resources and to contribute positively to the conservation of North Carolina's forestlands.

TACCIMO
Science at your Fingertips

Information in this pamphlet is summarized from over 300 peer-reviewed science papers found in the USDA Forest Service's TACCIMO tool. TACCIMO (the Template for Assessing Climate Change Impacts and Management Options) is a web-based application integrating climate change science with management and planning options through search and reporting tools that connect land managers with peer-reviewed information they can trust. For more information and the latest science about managing healthy forests for the future visit the TACCIMO tool online: **www.forestthreats.org/taccimotool**

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EMERGING THREATS TO YOUR FOREST AND RESOURCES

Threats to Forest Health - Invasive and aggressive plant and insect species may gain advantage over native species with future changes. Many forest pests are limited by winter freezes, and with increased temperatures these species will increase in number and very likely have a greater negative impact on our woodlands. Destructive insects, such as bark beetles, will be better able to take advantage of forests stressed by more frequent drought. Certain invasive plant species, such as Kudzu, are expected to increase dramatically as their large range and tolerance of harsh conditions will allow them to rapidly move into new areas.

Threats from Wildfire - Wildfire frequency is expected to increase across the region in the coming years. Increased drought and forest stress will lead to more dry fuels and chance for ignition. Increased cloud-to-ground lightning due to warming will increase the occurrence of wildfires. Prescribed burning will remain an important tool to reduce fuels on forest lands but may need to be altered as the number of dry, windy days when burning is prohibited will increase.

Threats to Timber - Impacts to timber resources from increasing carbon dioxide and fluctuating temperature and precipitation levels will likely be complex. Any increased growth rate due to elevated carbon dioxide could very well be reduced by decreasing water availability. Heat stress might limit the growth of some southern pines. Increased intensity of extreme weather events, such as hurricanes or ice storms, is also expected to lead to increased loss of timber.

Threats to Water Quantity and Quality - Shifts in rainfall patterns will lead to periods of flooding and drought that can have a major impact on our water resources. Increases in heavy downpours and more intense hurricanes can lead to greater erosion and more sedimentation in our waterways. Increased periods of drought may lead to decreasing oxygen content and poor water quality in some areas, as well as a higher demand for water resources. Sea level rise can cause increased potential for saltwater intrusion into our coastal freshwater tables.

Threats to Wetlands - Wetlands will be particularly vulnerable to changes in water supply due to changes in temperature and rainfall patterns. Alterations in the length of time that wetlands hold standing water and the change in the occurrence of extreme events such as hurricanes will affect both plant and animal communities in wetlands. Groundwater-fed wetlands, not associated with a river or stream, will be most vulnerable to changing climate as temperature and rainfall changes have the potential to lower groundwater table levels.

Threats to Wildlife - Wildlife species will be affected in different ways, depending on their requirements. Increased temperatures may begin to change the region's grass cover from cool to warm season grasses, which may in turn impact the quality of wildlife forage. Large mammals such as deer and bears might see a decreased need for food with lower winter temperatures and an overall increase in population size from higher winter survival. Birds, on the other hand, could see decreases in population sizes as vegetation types change and heat stress make migration more difficult. In order to adapt, arrival date and nesting times of some common birds may start earlier in the year.

Threats to Fish - Warming air and water temperatures and changes in stream flow will affect the abundance and distribution of fish species. With higher water temperatures, fish communities in North Carolina streams will begin to resemble communities in locations farther south. Altered stream flow patterns can lead to decreases in water quality and oxygen content. Cold-water adapted species, such as trout, will be the most vulnerable to population declines with future warming.

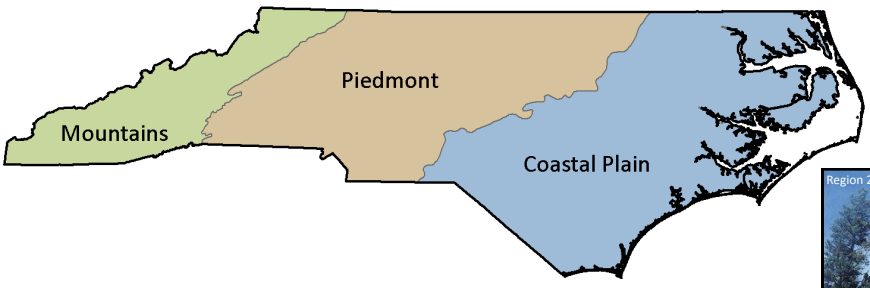
Threats to Biological Diversity - Plants and animals that are susceptible to fluctuating conditions will respond to environmental changes by adapting, moving, or declining. Species with high genetic variation will be better able to adapt to new conditions. Increasing temperatures will cause many species to shift ranges, generally moving north or up in elevation. However, in many cases land use changes will restrict the ability of plants and animals to move into suitable habitat. The species most likely to be negatively impacted by climate change will be highly specialized, habitat restricted species.

Threats to Soils - The quantity of organic matter, nutrient cycling, and water availability in soils are expected to change in the future, which will lead to changes in plant productivity. Higher temperatures will lead to increased decomposition of organic matter in soils, which over time can lead to an increased risk of soils compaction if Best Management Practices aren't utilized during harvests.

Threats to Recreation & Aesthetic Quality - Environmental changes may negatively impact recreational experiences due to increasing temperatures or changes to the plant and animal communities that make those recreational experiences unique. The visibility of mountain views may also be reduced, and increasing stresses on forests may impact the vividness of fall foliage colors.

Picture Credits: Water Quality—Gerald Holmes, Valent USA Corporation, Bugwood.org; Wildlife—Alfred Viola, Northeastern University, Bugwood.org

TOP EMERGING THREATS BY NORTH CAROLINA REGION



MOUNTAINS:

Threats to High-Elevation Forests – Changing temperature and rainfall patterns will mean that species from lower elevation areas will begin to migrate up-slope into mountain areas, changing the forest communities we see today. Populations of species now existing on mountain peaks will be most at risk in the future, as there will potentially be a complete loss of suitable habitat. This could mean the decline or extinction of high-elevation Spruce-Fir communities in the region. Forest landowners should consider focused conservation efforts for these threatened communities, including the removal of invasive species as they move into the area.

PIEDMONT:

Threats to Water Quantity – Increased temperatures, along with changes in spring and summer precipitation, are forecasted to lead to increased droughts throughout the southeast. In the piedmont region, where stream flows are already variable, more streams will be seasonally dry and reservoir levels may drop. Droughts will make forests more susceptible to threats from disturbance and dieback on large scales. Water resources available to forests can be increased by reducing the density of trees through thinning and wider plantings. These tactics should increase the water available to crop trees and help prevent drought-related dieback.

COASTAL PLAIN:

Threats from Sea Level Rise – Over the 20th century, tidal gauges in North Carolina have recorded an average rise in sea levels of over an inch per decade. The coastal regions of the state will continue to experience sea levels rise in the future at an increasing rate. Low-lying coastal wet forests may eventually become marshland as saltwater flooding increases. Increasing salinity of coastal aquifers is another possible consequence affecting forestlands, and any forests within three miles of the coast may be impacted. Landowners in these coastal areas can better prepare for future sea level changes by considering the planting of more salt-tolerant trees like Atlantic white cedar.

EMERGING THREATS & HEALTHY FOREST MANAGEMENT

Carrying out sound forest management practices should increase the odds of your woodlands remaining healthy now and for years to come.

Timber management activities provide forest managers and landowners with an opportunity to adapt their forests to multiple threats, including drought, invasive species, disease, and wildfire. Including adaptation as a landowner's management goal may provide multiple benefits and does not have to be costly. By using sound forest management practices that keep predicted future conditions in mind, landowners and managers can promote the immediate and long-term health of their forests and "hedge their bets" against these potential threats.

FOREST MANAGEMENT STRATEGIES TO ADDRESS EMERGING THREATS

Thinning: Periodically thinning woodlands helps to reduce overcrowded conditions and should concentrate growth on your best trees. Increased thinning can increase the water available to the remaining trees as well as reduce stand densities, both of which help to minimize risk from insects, disease, wildfires, and warmer temperatures. Thinning to slightly lower densities than traditionally recommended can help woodlands minimize stress from changing environmental conditions throughout the life of the forest. Intensified pre-commercial thinning may also be necessary to remove damaged or diseased trees and increase resources for the remaining trees.

Prescribed Fire: Prescribed fire will continue to remain a valuable management tool in the Southeast to reduce fuel loads and the chance of wildfires, as well as maintain ecosystem health. Landowners and managers, however, will need to consider the annual initiation of tree and understory growth as the climate warms. Prescribed fires will need to be carried out during periods that minimize damage to the crop trees and beneficial understory species. Expected changes in temperature, rainfall patterns and intensity of extreme events (for example, hurricanes) may shorten the window when prescribed burns may be carried out. An extension of the length of our region's wildfire season can also be expected.

Harvest: As changes in temperatures and rainfall patterns affect tree growth, woodland rotation lengths to reach the financial maximum may need to be altered. Shorter rotation lengths may be desirable in order to harvest the current trees and establish the next stand with tree species that are even more tolerant of changing environmental conditions and threats. However, landowners interested in managing for carbon sequestration may want to consider rotation lengths slightly longer than the financially optimal length associated with timber production. Leaving some residual vegetation or woody material onsite following harvests could help keep ground temperatures lower, which may in turn provide better habitat for some plant and wildlife species.

Site Preparation: Keeping some residual vegetation on site will help keep soil temperatures low and help maintain nutrients and soil moisture as temperature and rainfall levels fluctuate. Wider-spaced site preparation (for example, during bedding) could be used to help minimize future threats. Herbicide prescriptions may also need to be altered as invasive plants become more aggressive and new species move into the region. Site preparation through the use of prescribed fire will remain an important tool, but in some instances may need to be replaced with heavy equipment or herbicide alternatives due to rainfall or drought-related controlled burning limitations.

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Planting: Tree nurseries that diversify their seedbanks, by using either mixes of species or mixes of genetic traits from a single species, will help forest owners hedge their bets against future threats. Single-aged monocultures from a single genetic origin will be the most susceptible to future threats, while multi-aged mixed forests consisting of species with varying traits will be the most resilient. Choosing species known to grow in a wide range of conditions and withstand disturbance, including heat and drought stress, will also help maintain the health of the forest. The single decision of "what kind of tree seedlings to plant" will have lasting impacts on how you manage and maintain the health of your woodlands for decades to come.

Fertilization: As potential forest productivity increases with more carbon dioxide in the atmosphere, increasing fertilization will allow managers to take advantage of growth where nitrogen (N) is a limiting factor. However, changes in atmospheric nitrogen concentrations may lead to increased N deposition in some places, and N levels may need to be monitored prior to any applications of fertilizer. Fertilization could lead to trees with a smaller root area and more canopy growth, causing increased susceptibility to future drought stress.

While we encourage forest landowners to take the potential impacts of emerging threats into account when managing their woodlands, we ultimately recommend that landowners consult with your county forest ranger, forestry extension agent, or consulting forester to determine the best management approach for your unique property.

FOR MORE INFORMATION ON MANAGEMENT OPTIONS FOR YOUR WOODLANDS:

Contact your local County Ranger or the North Carolina Forest Service Central Office at 919-857-4801

www.ncforestservice.gov