Climate Change & Forests: What can we expect? What can we do about it?

By: Ethel Wilkerson and Andrew Whitman

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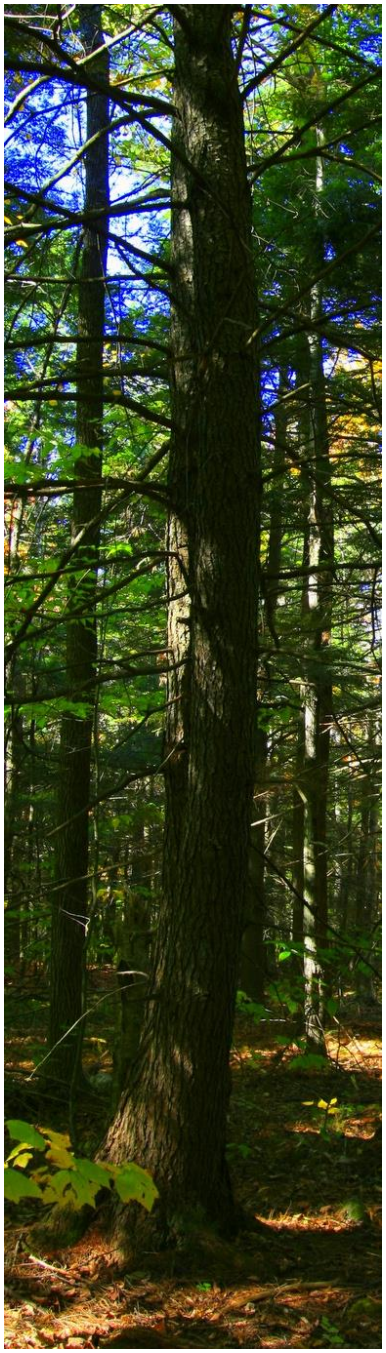

Climate Change & Forests—What can we expect?

In the next 100 years Maine is projected to become warmer and wetter in all four seasons (Jacobson et al. 2009), average temperatures in central Maine are projected to increase approximately 6-7°F, precipitation is predicted to increase about 10% (Jacobson et al. 2009, Hayhoe et al. 2007), and the depth and duration of snow cover is projected to decrease (Scott and Jones 2005). However, climate change is not a problem of the distant future. There is substantial evidence that changes in climate are already being observed:

- In the Northeast, average temperatures have increased >1.5°F since 1970, with winters having rapidly warmed 4°F between 1970 and 2000 (NECIA 2006).
- Average yearly precipitation and the number of large rain events (>1") in central Maine increased between 1948 and 2007 (Spierre and Wake 2010).
- Over the last 150 years, the length of the growing season in Maine has increased >40 days (Jacobson et al. 2009).
- The onset of first tree leaf out at Hubbard Brook in central New Hampshire has shifted 5-10 days earlier over the last 50 years (Richardson et al. 2006).
- The average number of days in Maine with snow cover has decreased between 4 to 24 days since 1965 (Frumhoff 2007).
- Data from over 65,000 forest inventory plots show evidence that 70% of tree species in the eastern U.S. had increased germination and seedling survival at the northern edge of species' range compared to the southern edge of range (USFS 2010). This means the geographic ranges of these trees are beginning to migrate northward.

The most challenging aspect of climate change may be the loss of predictability of traditional weather patterns. A few climate experts describe this phenomenon as "global weirding." Storms are projected to become more frequent and intense (UCS 2006), periods of extreme heat are expected to increase (Baker 1995), as will the frequency and severity of short- and long-term drought (Hayhoe et al. 2007). The increasing uncertainty and lack of predictability of weather makes it increasingly difficult to make both short- and long-term plans about management of forest resources.

Manomet Center for Conservation Sciences
14 Maine Street, Suite 410
Brunswick, Maine 04011

Contact: ewilkerson@manomet.org
(207) 721-9040 ext. 3

Alterations in temperature and precipitation patterns can impact forests in 5 important ways:

1. ***Reduce time period favorable for timber harvesting and transportation.***
   Reductions in the number of days with frozen soil, increases in the length of mud season, and increases in precipitation and large storm events will limit the number of days with favorable conditions for harvesting and transporting timber (Spittlehouse and Stewart 2003). This increases logging costs as machinery sits idle during marginal and unfavorable conditions and increases pressure on managers to operate during marginal or unfavorable conditions risking damage to soil and water quality.

2. ***Increase risks of damage to timber and infrastructure.***
   The increased frequency of large disturbance events (e.g., thunderstorms, ice storms, wind events) under a changing climate (Baker 1995, Union of Concerned Scientists 2006) may increase the risks of damage to financially mature stands. Each year in the United States ice and wind storms damage over 4 million acres of forests and cost landowners an estimated $860 million dollars (Michaels and Cherpack 1998, Herbert et al. 1996, Marsinko et al. 1997, USDA 1997, Dale et al. 2001). As the frequency and intensity of these disturbance events increase, damage to trees will increase. The storms can also degrade the condition of forest road networks and stream crossing structures (Gunn et al. 2009) which can dramatically increase logging costs.

3. ***Shift the distribution of tree species and wildlife habitats.***
   Forest types in the Northeast are predicted to change significantly in the next 100 years. Species are predicted to move northward and upslope as the climate changes. In Maine we expect several important species to decline including: sugar maple, red maple, black cherry, balsam fir, red spruce, yellow birch, paper birch, quaking aspen, eastern hemlock, American beech, and white ash (Iverson et al. 2008). Red oak and white oak are expected to extend their ranges northward and upslope (Iverson et al. 2008). White pine should remain viable in southern and central Maine for at least the next 100 years.

4. Increase threat of infestations of non-native species.

Climate change increases the risks associated with non-native species because the increased frequency of extreme weather events can stress native plants and favor establishment and growth of invasive species (Burke and Grime 1996). Forests are especially vulnerable after disturbance events when non-native species can out-compete native seedlings and saplings and quickly colonize these areas (Dukes and Mooney 1999). Climate change can also expand the geographic range of non-native species that were previously limited by climatic conditions such as cold weather (Skinner et al. 2003, Rahel and Olden 2008).

5. Change traditional recreational uses of forestland.

Climate change will alter the way the public uses forestland by changing the feasibility of traditional recreation activities. Trail-based winter recreation, including snowmobiling, cross-country skiing, and snowshoeing, are most vulnerable to climate change due to their dependence on natural snow (Scott and Jones 2005). In addition, vector-borne diseases, including Lyme disease and Eastern equine encephalitis (EEE), are projected to increase in central Maine (Robbins 2009, Sorg 2009, Harvard Medical School 2010). Exposure to these diseases is linked with time spent outdoors and users will need to take steps to reduce risks of exposure.

Climate Change & Forests—What can we do about it?

Climate change will alter many aspects of forests and forest management, and although managers and landowners cannot control the changes in climate (e.g., warmer temperatures, altered precipitation), we are not helpless in shaping the future condition of our forestland. ***The best way to plan and prepare for climate change is to practice good forestry.*** Tweaking existing forest management strategies can provide practical and cost-effective ways to minimize changes associated with climate change and helps ensure that Maine's forests continue to provide economic, ecological, and societal benefits for future generations.

Specific strategies for addressing climate change will vary by the forest types and geographic location of a property as well as the landowner's long-term management goals. These guidelines can provide some ideas on how to make your forestland more resilient to climate change.

Conduct sustainable timber harvests.

A shortened winter logging period, extended mud season, and increasingly frequent and severe storm events are likely to reduce the number of days with conditions favorable for low-impact logging. This increases logging costs as machinery sits idle during marginal and unfavorable conditions and increases pressure on managers to operate during marginal or unfavorable conditions, risking damage to soil and water quality.

Management Tips:

1. Apply best management practices (BMPs) and sustainable forestry practices to protect soils and water quality (see Maine Forest Service BMP manuals for details).
2. Create infrastructure that can withstand a variety of weather conditions.
3. Track and respond to changing soil and weather conditions and be prepared to take advantage of periods of favorable weather.
4. Consider using temporary bridges instead of culverts and permanent bridges to reduce risk of failure during storm events.
5. Use buffers along streams and wetlands to slow down storm water, prevent sediment and other chemicals from entering water bodies, and provide shade to keep water cool.

Maintain species, structural, and age class diversity.

Maintaining a diversity of forest species, structure, and age class are important in the face of climate change. Sustainable forest management can create a mosaic of habitats for existing wildlife species and new species that may shift into the area, diversify stands with species and age classes that are less vulnerable to climate impacts, protect against wide-spread damage and financial loss due to disturbance events, and create economic opportunities by managing for species that are well-suited to changing climatic conditions.

Management Tips:

1. Create multi-aged stands to provide a combination of mature trees, young trees, and seedlings. This can reduce risk of financial loss during disturbance events.
2. Create a variety of forest types and age classes across an ownership. For example, restrict harvesting in areas that are difficult to access or have high ecological value (e.g., riparian areas, uncommon habitats). In easily accessible areas, shorter-rotation forestry may be appropriate in order to capture mortality before it

occurs, minimize risk of disturbance to mature stands and allow establishment of young, vigorous trees.

3. If the property has plantations or stands dominated by a single species, create conditions that allow establishment of a variety of species types to minimize risk of pests that may target a specific species.

Think about "winners" and "losers" under climate change.

As the growing season increases so will the growth rate for many species. Warmer, wetter weather allows some species to grow and survive better than others over the next 100 years. These "losers" that are expected to decline over time include sugar maple, red maple, black cherry, balsam fir, red spruce, yellow birch, paper birch, quaking aspen, eastern hemlock, American beech, and white ash (Iverson et al. 2008). Climate "winners" include red oak, white oak, and white pine. Oaks and white pine are well-suited for the warmer temperatures and altered precipitation patterns expected under climate change in Maine and are highly valued for forest products.

Management Tips:

1. Work with a forester to create a management plan that considers climate change when making long-term management goals.
2. Use harvests to create conditions in which more well-adapted species can thrive and grow.
3. Monitor mature stands for signs of stress and decline and be prepared to harvest trees in order to capture mortality before the quality of wood products suffers.

Promote regeneration of native tree species.

Invasive plants are expected to thrive under a changing climate, allowing these species to outcompete native trees and quickly colonize forestland.

Management Tips:

1. Track existing and emerging threats of invasive species. The Maine Forest Service monitors and tracks this information across the state and provides periodic informational sessions and trainings.
2. Develop a modest but effective monitoring program for non-native species. In-depth monitoring for non-native species can be expensive. Concentrate your efforts in "hot-spots," including areas near current and historic roads (Gucinski et al. 2001, Sumners 2005), trails (Beninger-Truax et al. 1992), within recent harvests and other highly disturbed areas (Dukes and Mooney 1999), near waterways (Brzeskiewicz 2008), and near existing populations of invasives (Arim et al. 2006).

3. If a known threat has been identified in the area consider altering the timing of timber harvests and road construction to when the non-native species has the least risk of being transported to new areas.
4. Control non-native species at the early stages of infestation. If monitoring detects that regeneration of native species is being threatened by competition from non-native species, take immediate steps to remove and/or control non-native species. Early detection can prevent large infestations and can protect wildlife habitat and timber values.

Minimize negative impacts of disturbance events.

The frequency and intensity of widespread disturbances are predicted to increase due to climate change, resulting in injury or death of canopy trees and loss of economic value.

Management Tips:

1. Consider the vulnerability of specific species (e.g., softwoods and other shallow-rooted species) and stand features (e.g., ridgelines, buffers, forest edges) to disturbance events when creating harvest plans and management strategies. For example, softwoods are often shallow rooted and are prone to wind damage and these species may not be well suited for buffer strips or retention patches, especially on exposed ridges or near edges of harvest blocks or clearings.
2. For areas most vulnerable to disturbance events, evaluate the viability of existing infrastructure (e.g., landings, skid trails, haul roads) for salvage logging and, when feasible, develop multi-season access points that can be used in a variety of weather conditions.

   After a major disturbance or stand-replacing event periodically monitor the stand for the presence of non-native species. This is a time when non-native species can quickly become established and outcompete native species.

Create low-impact recreational trails.

Decreases in the depth and duration of snow cover and increases in extreme precipitation events associated with climate change may degrade trail quality and become a significant source of sediment to water bodies. If you permit snowmobiling or other public recreation on your land, make sure the trails and stream crossings are well designed and are not causing environmental or safety problems.

Management Tips:

1. Work with local clubs and trail users to evaluate the condition of trails and stream crossings and identify areas needing improvement. Increased precipitation can cause wet and muddy conditions that can quickly degrade trails, increase environmental damage, and decrease user enjoyment.
2. Trail closures during wet weather and marginal snow conditions can prevent damage to trail infrastructure, but in routinely wet or degraded areas consider improving or re-routing trails to avoid future problems. Snowmobile and ATV clubs are eligible for grants and cost-share funding for trail improvements, and lands with public access are eligible for recreation trail program grants for trail improvements.

Encourage deer management.

As winters warm in central Maine and the depth and duration of snow cover decreases, herd size and deer density will increase. Increased deer herds can damage vegetation, interfere with forest regeneration, and increase the abundance of deer ticks and instances of Lyme disease.

Management tips:

1. Monitor deer density numbers in your region and consider allowing hunting on your property to help maintain a healthy and viable deer population.

Be aware of other efforts and new resources for addressing climate impacts to forests. Climate change impacts multiple economic sectors (e.g., natural resources, transportation, public health), requiring coordination among landowners, government agencies, non-profits, and other stakeholders to effectively prepare for these changes. Preparation for climate change by individual landowners is important but some issues, such as wildlife habitat and water

quality, need to be tackled at a regional or watershed scale. Over time, new tools and financial assistance may be available to help landowners prepare and adapt to a changing climate.

Management Tips:

1. Government agencies and local land trusts can help identify regional priorities and help individual landowners collaborate on conservation goals.
2. As the importance of preparing for climate change is recognized there will be new tools and financial assistance available to landowners to help prepare for climate impacts.

Spotlight: Climate Change and Hemlocks

Hemlocks in Maine face several short-term and long-term challenges. In the short-term Hemlocks are vulnerable to infestations of Hemlock Wooly Adelgid (HWA) and Elongate Hemlock Scale (EHS) that cause stand damage and eventual mortality. Over the long-term, hemlocks may not fare well in across southern, coastal, and central Maine because they are adapted for a cool climate. If you have hemlocks on your property you can:

- Track reports of infestations across the state to determine the risk to your trees.
- Monitor hemlock stands for infestation.
- If infestations are detected in close proximity to your land, conduct harvests when these species are least mobile (from mid-August to February) to reduce risk of transporting these species to new areas.
- Investigate practicality of using biological controls to minimize stand damage.

Once stands are infested landowners have 2 options: (1) let hemlocks decline and allow stands to slowly transition to deciduous hardwoods (Orwig and Foster 1998, Orwig 2002) and white pines (Kizlinksi et al. 2002) or (2) harvest hemlocks before significant declines to capture financial value, speed up stand conversion (Orwig and Kittredge 2005) to species that are better suited to a warmer, wetter climate. A combination of these approaches at the site can help balance short- and long-term economic and environmental objectives.

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