"A Web of Life and Livelihood on the Chopping Block"

The Impacts of Global Warming and Climate Change on the Allegheny Highlands

2022 Working Bibliography Prepared by Friends of Blackwater and the West Virginia Center on Climate Change ("WV3C")

Introduction by Thomas Rodd, WV3C Director

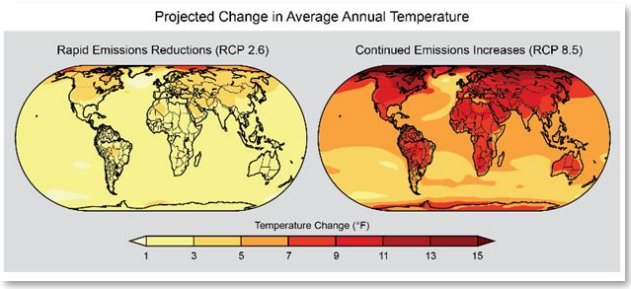
The Allegheny Highlands region of the Appalachian Mountains spans portions of Pennsylvania, Maryland, West Virginia, and Virginia.

In this region, the calendar year begins with a bracing, snow-clad winter, followed by a moist, vibrant spring. Then come the warm days and cool nights of summer, followed by autumn frosts that prepare the Highlands for another season's wintery blanket.

For many generations, the Allegheny Highlands climate has supported a diverse economy and ecology, an intricate web of life and livelihood. In recent years, however, the impacts of human-caused global warming and climate change – rising temperatures and heat waves; more intense precipitation, flooding, and drought; markedly changed growing seasons; altered forest and plant and animal species; and even plant and animal extinction – are taking a growing toll on the Highlands region.

In 2014, the conservation group Friends of Blackwater first prepared this working scientific bibliography on the impacts of global warming and climate change on the Highlands. This version is updated to 2022. The summary presented in this introduction is compiled from reports in the bibliography. The growing body of research on how forestlands store carbon and reduce the concentration of greenhouse gases in the atmosphere is not addressed in this compilation. Other Friends of Blackwater publications address this important topic.

Thanks to Alderson-Broaddus University student Sofia Hernandez and Professor Sarah Cross for their research and compilation work. Special thanks to the Appalachian Stewardship Foundation and the Dunn Foundation for their support for this publication. For more information, visit https://saveblackwater.org.



Impacts on Temperature and Precipitation

Temperatures in the region of the United States that includes most of the Allegheny Highlands have risen by about two degrees Fahrenheit over the past one hundred years, and they are expected to continue to rise, accompanied by a greatly diminished winter snowpack. The average period of frost-free temperatures has moved about ten days forward in the spring and ten days backward in the fall. This frost-free period is projected to continue to expand by a month or more.

Under "business-as-usual" high-greenhouse-gas-emission scenarios, the number of days when temperatures in the Highlands fall below 10 degrees will continue to decline by 50 percent or more, and cold periods that have historically lasted for a week or more will likely last only a day or two. The number of "heat-wave" periods where the temperature exceeds 95 degrees, is expected to triple.

Warming temperatures intensify the water cycle. Between 1895 and 2011 average annual precipitation in the Northeast region has increased by approximately five inches, or more than 10%. This figure is projected to increase by 40% by 2100, under high-emission scenarios. Climate change is also increasing the frequency and severity of very heavy precipitation events (defined as the heaviest 1% of all daily events) in the region. Between 1958 and 2010 the Northeast Region experienced a greater increase in extreme precipitation than any other region in the U.S.; more than 70%. This trend will increase as climate change impacts grow.

Warmer temperatures also cause the air to expand, and increase rates of evaporation and evapotranspiration, leading to soils drying faster, especially in spring and summer. This increases stress on moisture-sensitive Highlands ecosystems like peat bogs and aquatic habitats.

Impacts on Forests

The Highlands ecosystem is characterized by scientists as the Appalachian Hemlock Northern Hardwood Forest, and as "highly vulnerable" to climate change. A major driver of the vulnerability of the Highlands forest ecosystem to climate change is decreasing precipitation in summer and fall, and increasing temperatures and reduced soil moisture. The dominant species of this region – American Beech, Eastern Hemlock, Sugar Maple, Tulip tree, Black Cherry, White Ash, Yellow Birch, and Red Spruce – are projected to decline substantially as a result of changes in the atmosphere that are already in place.

Under high greenhouse-gas emissions scenarios, suitable habitat for important tree species like the sugar maple and red spruce disappears. To replace these species, heat-tolerant trees

like the loblolly pine, now abundant in States like Georgia, are expected to become prominent in the Highlands.

The 2015 Pennsylvania Climate Assessment states that forest product manufacturers and consumers may benefit from lower costs as more dying trees are harvested due to a changing climate, but forest landowners will likely be losers. The study says that the outlook for one forest product, maple syrup, "looks bleak." Additionally, with invasive species like the hemlock wooly adelgid already a major problem, climate-related threats to forest health in the Highlands from pests and disease are growing.

Impacts on Aquatic Life

Stream temperatures in the Allegheny Highlands have steadily increased over the past forty years as a result of global warming. These rising temperatures pose a severe threat to stream ecology and biodiversity. For example, an upper stream temperature range of 68-77 degrees Fahrenheit is a critical zone for the Eastern Brook Trout, the state fish of Pennsylvania, Virginia, and West Virginia. Summer stream temperatures in the Highlands are increasingly in that zone of caution.

A summer heat wave may increase water temperature over 74°F for a week or more. While such a temperature spike might have a small impact on a stream's annual average water temperature, it can cause the local extirpation of species that are impaired by waters warmer than 70°F. Today, Eastern Brook Trout are gone from a third of their former homes in Appalachia's cold-water streams. Suitable habitat for brook trout could well disappear from the Highlands in this century.

Impacts on Wildlife

In 2011 the West Virginia Division of Natural Resources assessed 185 wildlife species for their vulnerability to the impacts of climate change. They classified 8 amphibian species, 4 bird species, 11 fish species, 6 mammal species, 2 reptile species, 18 mollusk or shellfish species, 12 crayfish species, 20 insect species, and 21 plant species as "extremely vulnerable" to "moderately vulnerable" to the impacts of climate change.

One species classified as highly vulnerable is the West Virginia Northern Flying Squirrel, or "Ginny," as she is called by people who are working to protect her. There are less than 1,000 of Ginny's species in the entire world, all are in just seven counties in the Allegheny Highlands. Today, one of Ginny's prime habitat locations is the Blackwater Canyon, which Friends of Blackwater works to protect. But preserving the Blackwater Canyon will not

save Ginny from extinction, unless we rein in the global warming that is destroying her habitat.

Impacts on the Tourism, Outdoor Recreation, and Hospitality Industry

Climate change impacts like increasing temperatures and heat waves, more intense precipitation and flooding, periodic drought, rain replacing snow, the loss of historic forests and changing weather patterns, extirpation of high-value sporting species like the brook trout – these impacts threaten the Highlands' distinctive outdoor recreation and hospitality industry. Ski season length in the Highlands region under a high-emissions greenhouse gas scenario would decrease by as much as 50 percent. It is questionable whether ski resorts would be economically viable with such short seasons. This risk to a signature regional economic engine is troubling.

Our Choices

What can we do to best protect the Highlands from the adverse impacts of global warming and climate change? What climate-smart choices can we make?

One smart choice is to learn and talk about what climate change is and what it means – so that we better understand what's at stake and what's at risk. Another is to plan and prepare for the impacts of climate change that we cannot avoid.

Just as communities in Virginia and New Jersey are building seawalls and infrastructure to reduce the harm of sea-level rise, people who care for the Allegheny Highlands can increase their preparedness and their resilience to climate change impacts. Planners and builders can strengthen bridges, roads, and buildings in the Highlands to reduce harm from flooding and severe weather. Landowners and managers can build wildlife corridors and preserve critical landscapes to help endangered species find refuge from rising temperatures. Scientists can devise remedies to hold back climate-related diseases and pests.

Another smart choice is to support local, national, and global policies that will reduce global greenhouse gas emissions, to prevent the most dangerous impacts of global warming and climate change. It will take the efforts of scientists, businesses, people, and governments all around the world to address the crisis of global warming and climate change. "Ginny" and her Highlands friends are counting on us!

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