tracking the impacts of climate change on mount monadnock

By Meg Fairchild

As the last patches of snow melt away, and the spring ephemerals begin to bloom, hikers from New England and beyond flock to the Monadnock region to climb the iconic mountain that has captured our attention for centuries. To some veteran visitors, Mount Monadnock remains much the same year after year, but those with a keen eye just might notice the changes taking place on the mountain's slopes.

Some changes on Monadnock occur so slowly that they go undetected over a human lifetime. Others are so cyclical and predictable that they have faded into the background of our consciousness. Whether we turn our attention to the geologic shifts that take place over millions of years, dramatic temperature swings or severe weather events that occur in a single day, or the transforming composition of forest communities over decades, one cannot deny that change is a constant on the mountain. In an era where the word 'change' seems to be on everyone's lips, one cannot help but wonder what effects a changing climate will have on the forests and mountains in our region.

Change has been both the inspiration and the driving force behind much of the work of the Monadnock Ecological Research and Education (MERE) Project, an initiative started in 2007 by Antioch University New England Professor Peter Palmiotto and graduate students in the environmental studies department. Through collaborative partnerships with Monadnock State Park, the Society for the Protection of New Hampshire Forests, the Monadnock Advisory Commission, and the Town of Jaffrey, the MERE Project ultimately seeks to promote informed use and foster appreciation of Mount Monadnock through ecological research, monitoring, and educational outreach. The project is funded by Antioch University Faculty research grants, the Walter Fund of the NH Charitable Foundation, and the Waterman Fund.

Facing page: *Antioch Master's student Matt Walter measures the girth of a red spruce on Mount Monadnock. As average annual temperatures rise, the elevation and latitude where red spruce currently grow will become too warm for them to compete with other, more tolerant species. The cold-loving tree will migrate northward and to higher elevations, chasing a cooler climate. Photo by Dave Mallard.*

Left: MERE students measure a rather large crevice community. Photo courtesy of the MERE project.

THREATS OF CLIMATE CHANGE By Annie Jacobs

A recent report of The Northeast Climate Impacts Assessment (NECIA) predicts that forest communities will change along with climate trends. As the temperatures rise and growing conditions transform, plant and animal communities are expected to move northward in search of suitable habitat, and more southern species will move in to take their places. The report predicts that new combinations of plant species might assemble based on the environmental conditions. On Mount Monadnock, for example, the cold-loving red spruce might disappear from the mountain. In addition, red oak, which is more dominant below 2000', may increase in dominance higher up the mountain.

Changes in climate will also influence the spread of forest pests, pathogens, and invasive species. The hemlock wooly adelgid, an invasive insect that can decimate eastern hemlock forests, is currently spreading northward. It is kept at bay by cold winter temperatures, but warming trends might allow it to reach forests as far north as Canada.

As a result of climate change, NECIA lists northern plant communities, such as spruce-fir forests, at risk. This forest type covers much of New Hampshire, Maine, Vermont, and New York and provides for the paper and pulp industry. It also harbors wildlife such as the snowshoe hare and the Canada lynx. The high-elevation spruce-fir forest found on Monadnock and other mountains provides nesting habitat for the Bicknell's thrush, a neotropical migrant. What's more, the increased carbon dioxide that causes warming may promote faster growth and greater demands on soil nutrients, further altering local ecology. In these ways, the compounding effects of climate change will influence the ecology, economy, and recreation associated with Northeastern forests.

As the southern-most subalpine peak in New England, with 95,000 visitors each year, Monadnock is the perfect place to study both the effects of climate change and public education on forest ecosystem communities.

Professor Palmiotto and master's students David Mallard and Matt Walter began the work of the MERE Project in the spring of 2007 by establishing 88 permanent, long-term ecological research plots on the slopes of Mount Monadnock. The plots were located between 2,000 and 3,000 feet elevation—the area below tree-line that is owned by the Forest Society, the Town of Jaffrey, and the State of New Hampshire. Information collected from these research plots was later compiled in Mallard's thesis describing the distribution and species composition of the mountain's eight forest communities.

Unique Ecology

In total, Mallard identified seven distinct natural communities within the 1,000-foot elevational band of the mountain that he studied (see Figure 1). Both subalpine communities found near Monadnock's summit—subalpine rocky bald and sheep laurel-Labrador tea heath-krummholz—are considered exemplary natural communities in New Hampshire because of their rarity. Furthermore, these communities are vulnerable to extinction particularly on Mount Monadnock due to the high volume of foot traffic. Although the exact cause is unknown, sheep laurel in the latter community is exhibiting widespread browning of foliage, indicating increased stress.

Three of the other forest communities identified are locally significant because their existence on Mount Monadnock is at or near the edge of their natural range, making them particularly susceptible to added stress. In fact, Mount Monadnock's location on the landscape places it at the edge of two different ecoregions, which, together with its disturbance history and elevation, allows it to support all three New Hampshire biomes: alpine tundra, boreal forest, and eastern deciduous forest.

Mallard believes that Mount Monadnock's ecology and location make it an ideal subject for studying the potential impacts of climate change.

"Given the range of natural communities that are present on Mount Monadnock, the location of the mountain in relation to the communities' ranges, and the projected ecological changes to occur," he said, "it is reasonable to suggest that Mount Monadnock will be extremely valuable in determining rates of change on mountain ecosystems resulting from climate change."

All of the baseline data collected by Mallard will serve as a resource for the MERE Project's long-term studies, with resampling scheduled every five years. This information will be crucial for evaluating the course of climate change in the decades to come.

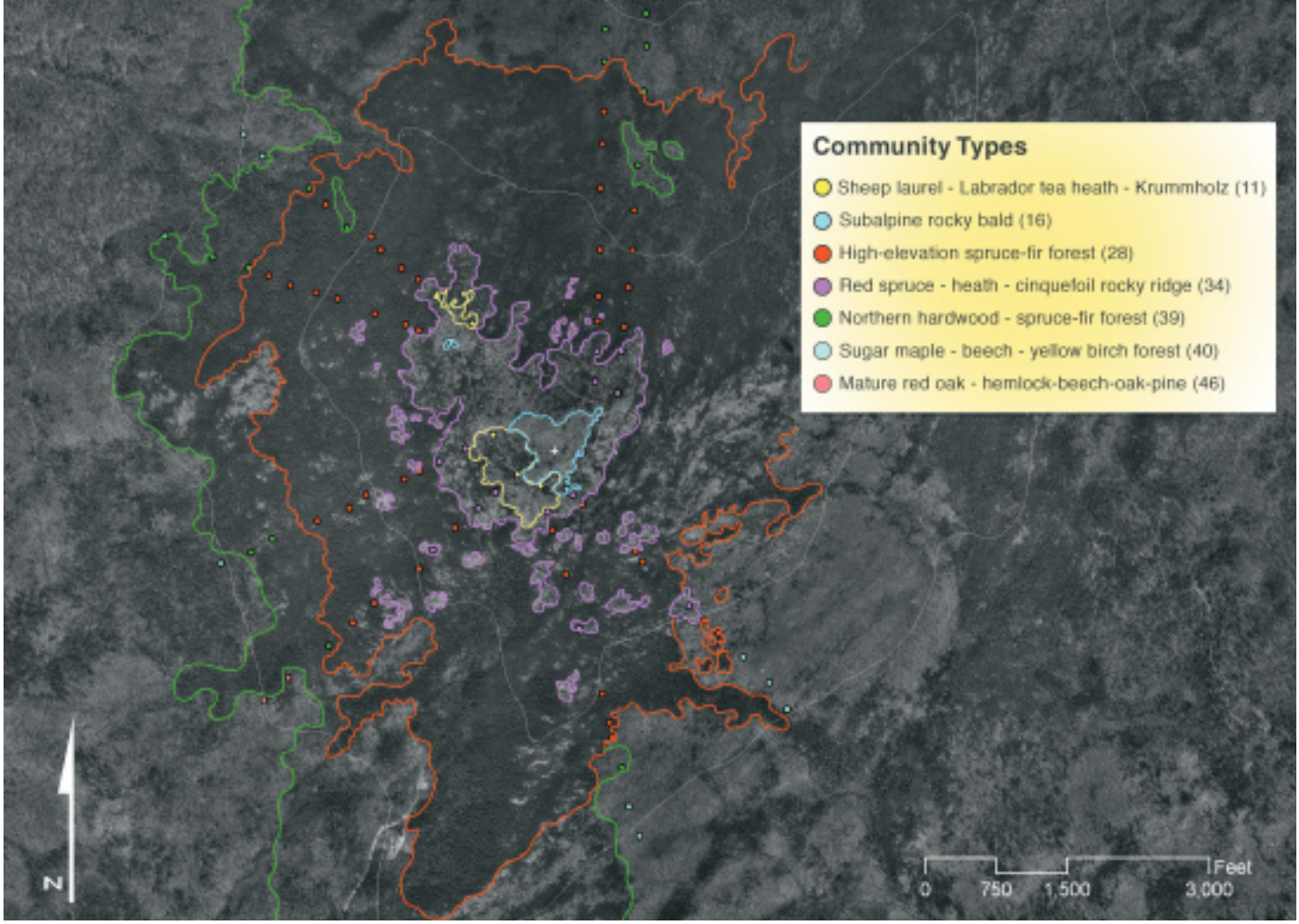


Figure 1. *All three of New Hampshire's biomes—alpine tundra, boreal forest, and eastern-deciduous forest—can be found on Mount Monadnock. These biomes include plant communities that are typically found at more northern latitudes and higher altitudes. For instance, the high-elevation spruce-fir forests (red) on the mountain's upper slopes replicate lowland forests at more northern latitudes. The rocky balds (turquoise) on Monadnock's 3,165-foot summit are home to sub-alpine plant communities found at higher elevations in the White Mountains.* Map by Dave Mallard, 2008.

Red Spruce: One Barometer for Climate Change

The rather large red spruce population on Mount Monadnock may be the first to show the effects of climate change. A 2007 report of The Northeast Climate Impacts Assessment (NECIA) predicts that cold-loving species such as red spruce will "migrate" northward and to higher elevations, chasing a cooler climate. As average annual temperatures rise, the elevation and latitude where red spruce currently grow will become too warm for them to compete with other, more tolerant, species.

Professor Palmiotto, a forest ecologist both by training and by heart says, "If climate change continues, red spruce will recede. So the question I ask is, 'What will happen to the system if all the red spruce die on Monadnock?' Now that we have permanent plots and trees measured and marked, we will be able to see the change as it occurs. The mountain will be a marker for the region."

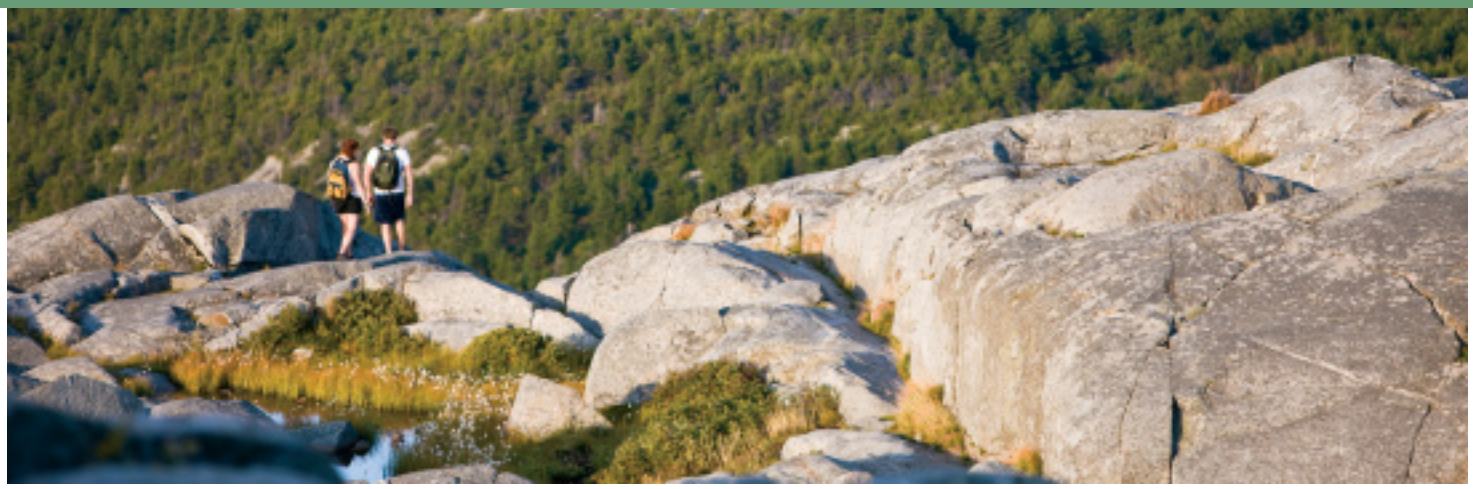
A rapid spruce die-off could increase the potential for fire on Mount Monadnock's slopes, which could in turn lead to a massive loss of soil and subsequently a lower tree line. However, if a change of natural community composition takes place more slowly, red spruce would likely be replaced by hardwoods that are better suited to warmer climates.

Collecting the Data

The 88 research plots established by Mallard will also be visited by other Antioch master's students to collect additional information about the ecology of Mount Monadnock. Student Melissa Green visited the plots during the summer of 2008 to record which species occur in the understory, and Amber Boland hiked the mountain this spring to survey the damage to the plots from the massive ice storm in December 2008. On Mount Monadnock, the damage was so severe that all trails remained closed to the public for nearly a month. Even by mid-March, only three trails were sufficiently cleared to allow hikers safe passage all the way to the top. Another student, Alex Coombs, is collecting plant specimens from the entire mountain to build a species reference that will be housed at the Antioch New England herbarium.

In 2010 Professor Palmiotto will recruit new students to study intensively the subalpine rocky bald of Monadnock's summit. When combined, the wealth of information from the various studies of the MERE Project will provide a grand picture of the current ecology of Mount Monadnock, something that's been lacking since Henry David Thoreau wrote down his casual observations of Monadnock's natural history in the 1850s,

SOME CHANGES ON MONADNOCK OCCUR SO SLOWLY THAT THEY GO UNDETECTED OVER A HUMAN LIFETIME. OTHERS ARE SO CYCLICAL AND PREDICTABLE THAT THEY HAVE FADED INTO THE BACKGROUND OF OUR CONSCIOUSNESS.



To some veteran visitors, Mount Monadnock remains much the same year after year, but those with a keen eye just might notice the changes taking place on the mountain's slopes. Photo by Jerry and Marcy Monkman, EcoPhotography.

and Henry Ives Baldwin conducted a systematic study describing Monadnock's flora in the 1970s.

Engaging the Public

However, the MERE Project is doing more than just scientific studies on the slopes of Mount Monadnock. Educating the public from an informed position is another key project goal. This past fall, students from Marshall Davenson's Advance Placement Environmental Science class at Keene High School, in partnership with the MERE Project, hiked to Monadnock's summit to begin piloting research methods for studying the mountain's crevice communities—small pockets of vegetation growing wherever soil has collected in the cracks and indentations of the granite bedrock. Crevice communities, which thrive on the rocky terrain on the top of Monadnock, are uniquely adapted to the extreme habitat of the mountain and have gone through many years of succession in order to reach their current level of biodiversity.

In May 2009, the high school students returned to the summit to collect baseline data describing the size and species composition of selected crevice communities. This effort will be crucial for studying the effect of human trampling on vegetation in areas where hikers, often unknowingly, leave the marked trails to take in the spectacular views.

In the months and years to come, the MERE Project plans to implement various education programs, using the information that both Antioch and Keene High School students collect, to inform the public about the negative impacts humans have had on the vulnerable plant communities of Monadnock and what actions can be taken to prevent further damage. In spring 2009, three trail stewards began hiking the mountain each weekend to engage the public and describe what the MERE Project has learned thus far. Students will welcome and converse with visitors about how to use the mountain's trails in the safest way possible and how to preserve vegetation by hiking in the right places.

So, the next time you hike Monadnock, be sure to watch for some of the changes that are taking place all around you. The ecology, the vegetation, and even the people you encounter may be new and different from your last visit. One thing is certain: In the future, there will be many more Antioch New England graduate students on the mountain working to conduct research, to educate the public, and to preserve and protect the mountain's spirit and ecology for generations to come.

Meg Fairchild is currently a graduate student at Antioch University New England and has served as Project Coordinator for the MERE Project since September 2008. As a native of the topographically flat state of Michigan, she has been grateful for the opportunity to fall in love with such a beautiful, unique, and iconic mountain, which seems to provide a grounding consistency to both residents and visitors of this region, even when change is indeed the only true constant on Mount Monadnock.

For more information about the MERE Project, contact Professor Peter Palmiotto at Antioch University New England or visit **www.antiochne.edu/mere**