

BLACK ROCK FOREST NEWS

Spring 2017

Black Rock Forest Consortium

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Understanding Biodiversity: New Research

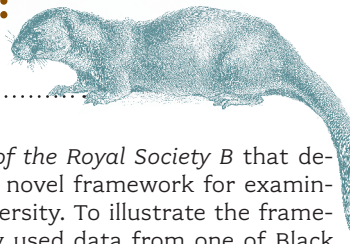
For many, the word “biodiversity” refers to the number of species, or *species richness*, whether plant, animal, or microorganism. But the number of species tells us little about what makes biodiversity so important to healthy ecosystems. Indeed, the term, *biodiversity* was created in the 1980s specifically to refer to all the ways the diversity of life on Earth matters, because scientists were concerned that the common practice of just looking at species richness was a poor way to understand the significance of life’s extraordinary diversity.

However, it can get pretty dauntingly complex if one wants to consider all the dimensions of biodiversity. Daunting though it may be, a study at Black Rock Forest shows why it is so very important for us to take a multidimensional view.

In December of 2016, Shahid Naeem, a Professor of Ecology at Columbia University, and colleagues published a paper in the prestigious science journal *Pro-*

ceedings of the Royal Society B that developed a novel framework for examining biodiversity. To illustrate the framework they used data from one of Black Rock Forest’s long-term studies of forest vegetation responses to environmental change. The study begins by noting that biodiversity is well known to be multi-dimensional, but is rarely treated as such. They backed up this claim by reviewing biodiversity studies published over a 15-year period and found that the vast majority focused on just one dimension of biodiversity: taxonomic diversity, a measure of the number and relative abundance of species and nothing else. This focus, they argued, limits the conclusions that can be drawn and sometimes misses important ways that biodiversity matters.

What are the other dimensions of biodiversity? There are many, taxonomic diversity being just one. There is phy-
(continued on page 5)



Hikes Program Launches

On a cold day in February, Forest Manager John Brady gathered 21 adults and three young children for a winter hike, part of a new program to introduce Black Rock Forest to newcomers and unearth a few secrets for old Forest friends.

As the group walked about two miles, Brady discussed winter’s effect on animals, deer herd patterns of behavior, tracking deer in fresh snow and more. Brady also touched on Forest history by passing out archival photos, some of which showed the Upper Reservoir dam under construction in the 1860’s, and talked about how different spots in the Forest evolved over time. Hikers were eager to benefit from Brady’s 30+ years in the Forest, peppering him with questions. One of our youngest participants summed it up, exclaiming at the end, “That was beautiful!”

We have a roster of hikes planned for the spring and summer and hope you will lace up your boots and join us to deepen your knowledge of Black Rock Forest and the education and research that happens here! Hike leaders include Consortium staff, members of the Board Directors, and Consortium members including a Barnard College professor and Head of Science at The Browning School.

(continued on page 5)

TOP: Looking at archival photos of BRF in the 1860’s.



Exclosures like the ones Naeem and colleagues studied protect plants from deer browsing and generally, over time, develop denser vegetation, especially denser and taller stands of woody plants.

Report from the Forest Manager

Winter's deer tracking census continues to monitor deer herds and provide reminders of life's lessons. Data from the fall hunting season supplied information of a low population, harvesting 23 deer. All age classes demonstrated healthy antler beam diameter of bucks and weights of does as the herd entered the winter season.

Tracking season started December 18 with a snow fall of 6," enough to detect the proper deer track imprint in the snow. Taking advantage of deer's innate behavior to seek out sheltered habitat within their winter range before upcoming storms and subsequent movement. Given an appropriate time period of movement, 12 hours, fresh track is available to census. Up to 15 miles of roads in Black Rock Forest create the access to perform such a census. The first transect revealed 33 deer by 20 road crossings. Fresh track from proceeding transects after every new snow event improves familiarity with deer group numbers and their behavior.

Just past Buster's Bend, a small single fawn was repeatedly tracked until two sequential, February snowfall events, totaling 20" in the Forest by February 12, that were followed by wind, cold and ice. Deer movement stopped. By February 16, the orphan button buck was found, killed by coyotes. This is only the third such instance of a confirmed kill by coyotes in over 20 years of Black Rock tracking.

Backtracking the fawn's fatal course showed the 14" snow-pack, crusted with ice. The hoofed, short legged fawn could only jump, up to 10 feet, before crashing through the ice crusted snow. The coyotes left no prints as they could move about freely on top of the snow. Up the south slope of Black Rock



Mountain they turned right back around, crossing White Oak Road and into the stream that feeds the brook trout pools. Here two coyote tracks were finally identified as they passed through the stream's mud. The final tracks, where it all began, revealed that the fawn had not left its bedding area since before the snows of four days past. The button buck was diagnosed healthy after exposing the white bone marrow of the deer's femur bone. Healthy deer are usually no match for pursuing coyotes, until conditions change.

Tracking throughout the forest during mid-winter begins to show the grouping of deer. This social behavior is a survival instinct. Within the group is usually an adult female whose habits will increase the chances of survival. Occasionally, orphans are created. Without the influence of adult survival behavior, fawns may create situations of their demise.

The fawn carcass was left with a motion camera mounted on a nearby tree. The scavengers caught on camera included red fox, crows, ravens, hawks and vultures, crowned by the presence of a mature Bald Eagle. Most interesting was the absence of the coyotes which started the lesson.

By March, the winter had dropped 42 inches of snow during eight events, creating 12 tracking opportunities. Sixty two deer overwintering as 27 groups were distinguished on the five square miles studied. The estimated overwintering deer density of 12.4 deer per square mile demonstrates the continued slow recovery of deer numbers sustained by coyote influence.

— John Brady

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The Black Rock Forest Consortium advances scientific understanding through research, education and conservation programs. It is a not-for-profit 501(c)(3) organization supported by membership dues, grants, and gifts.

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Curriculum Development: Archaeology Project for Fourth Graders

At the start of a new school year, teachers often reflect on the past year's work and look for a new project. Many are interested in projects that take students a full year to complete. Together we brainstorm, blending the teacher's knowledge of his or her students with our knowledge of the Forest. Can we build an experience that is fun, exciting, and educationally rewarding?

During an August meeting with fourth grade teachers, the question was asked, "Is local history still part of the grade four curriculum?" It is, and the teachers were interested in the Stone House, Continental Road and the White Oak Tree. Another question pulled on the idea that people lived and worked in the forest. We were asked, "How do you know that?" The answer was that there are three sites in the Forest that have noticeable signs of human involvement. We asked the teachers, "Do you think your fourth graders would like to investigate?" Together we walked through the sites, developed a plan, and scheduled visits to the school and Forest.

One archaeological site is close by the corner of Continental Road and Sutherland Road, very near to where Hulse Road begins at Two Gates. The remains of a homestead tell us that people lived here years ago. A pile of rocks reveals a collapsed stone house or its foundation. There also seem to be stone walls that set off the property line. Two stone walls join to form a corner that face a circular pile of rocks. Why would people build a circle with rocks?

As the project unfolded, the class was divided into teams. Each team took on a different section of the property. They moved rocks, scraped the ground with rakes and shovels, and cleared away leaves and twigs. If artifacts were found, they were bagged and labeled. Parents helped with this. Students wanted to know, "Are bricks ar-



"How do you find North?" Jack Caldwell teaches students how to use a compass to draw a map of their archaeological dig site.

tifacts too?" We found so many little pieces of ceramic and pottery, students asked us. "Can we put them together by color?" Clean them off first, they were told.

The questions continued. "Can we make a map of this place?" "I want to use the tape measure to see how big this place is." "The map needs to show North. Which way is North?" "Can you tell how big the horse was by the size of the horseshoe we found, because the horseshoe the other class found at their site is smaller?" With dirt on their hands, the questions continued.

Fourth graders travelled to the other two sites. One site may have had a small building on it. The students will have to come back to gather more evidence to determine what was going on here. The third site was very different from the other two. You could see wagon wheel marks pressed into the ground. Small mounds of dirt outline rectangular shapes on the forest floor. A buzzing metal detector added to the excitement as bits and pieces of objects were uncovered.

Outdoor teaching and learning events happen with surprise and wonder. Reading and writing opportunities are not difficult to find. A variety of tools are needed to measure and record information and data. Ways to share what happened in the Forest become classroom challenges. Pictures and stories, graphs and charts are used to make visual representations of the data. Modern technology can be used to create a virtual experience. But how will this experience show on the standardized exams? Teachers have to strike a balance between generating excitement in their students through memorable, hands-on experiences in the field, and mastering the material that's required, in the time that they have. And yet, students tell us after each visit to the Forest, "That was the best field trip ever!" 🌲

—Jack Caldwell, Operations Manager



Cornwall students use a 24 foot log on Continental Road to build a timeline. Students use a measuring tape and their math skills to place cards evenly over a 300-year timeline. Then they place their archaeological finds in the context of the timeline.



John Brady explains how to measure the age of a tree using a tree cookie and coring. The year 1730 will be on the students' timeline, as it was the first year of life for the nearly 300-year-old White Oak Tree.

The Storm King School Helps Oak Wilt Study

Oak wilt, caused by the fungus *Ceratocytis fagacearum*, has been found in New York by the Department of Environmental Conservation (DEC) as of December, 2016. Left untreated, the disease could destroy infected trees and spread through oak-dominated forests, changing their composition dramatically.

On Martin Luther King Jr. Day, student volunteers from The Storm King School collected tree growth measurements on Black Rock Mountain. The students learned how to add to a 10-year data set for an experiment designed by Consortium scientists to explore the impact of the loss of oaks as foundation taxa of the Forest. Researchers are assessing how oak loss, accelerated by pathogens like oak wilt, would affect Northeastern forests, from the rate of growth of the surviving species to understory response, soil composition changes, and more.

The students measured hundreds of trees on plots where scientists had sim-



Measuring Trees in Black Rock Forest

ulated the conditions of oak loss. The data show red maples (*Acer rubrum*) and black birch (*Betula lenta*) to be growing more rapidly than other trees. While the birches and maples provide some ecosystem services, they do not replace many valuable functions of oaks, like conserving nitrogen and providing acorns, an important food source for wildlife.

Ideally, proper forest management will prevent the spread of pests and pathogens like oak wilt, but individuals can help, too. What to do includes obtaining firewood from less than 50 miles away and not pruning oaks in the spring or summer. Oak wilt can be identified when the leaves at the top of the tree begin turning bronze and then brown in the spring and summer. This will spread downward and cause a complete wilt within six weeks. Red oak species rarely survive more than a year from infection while white oaks can survive longer. ♻️

—Sara J. Pace

NYU Artist in Residence to Teach Summer Photography Course



Peter Terezakis, Artist in Residence at New York University's Tisch School of the Arts, will teach a new outdoor photography course for middle school students this July as part of Summer Science Day Camp.

Terezakis is a mixed media artist whose work frequently includes photography of natural landscapes, performance art, animation, design, jewelry and technology. After witnessing the melting of glaciers in Greenland and discovering the prevalence of anthropogenic impurities, including concentrations of soot on these remote glaciers, Terezakis became interested in environmental issues and conservation.

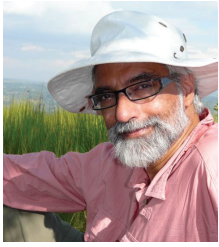
As Associate Arts Professor at NYU, Terezakis teaches "Green World," in which students use the visual arts, writing, and directing to tell stories about environmental issues important to them. When Terezakis brings NYU students from this class to Black Rock Forest, they see and learn to describe a sky full of stars, comparing it to the night sky seen from the city.

Terezakis's Science Camp course will explore the science of vision and perception, from how light enters the eye and is translated to an image in the brain, through exploration of the visible light spectrum. ♻️

—Sara J. Pace



LEFT: Peter Terezakis pictured here photographing in large format in dusty Death Valley. Photo: Allyson Green. ABOVE: Students taking pictures in Summer Science Camp 2016. Photo: Sara. Pace

Understanding Biodiversity (continued from page 1)

logenetic, functional, genomic, genetic, spatial, temporal, trophic, network, and much more — each dimension being quite complex in its own right. The authors focused on the three most widely studied dimensions, including taxonomic, but also *functional diversity*, a measure of the different kinds of traits species possess, such as whether they can fix nitrogen or not, what the average

thickness of their leaves is, how efficient they are at nutrient or water uptake, what their rates of photosynthesis are, and more. The third was *phylogenetic diversity*, which assesses the variety of evolutionary histories represented in the species of an area. Phylogenetic diversity takes both the more recent and the “deeper” branches of the phylogenetic tree into account, which is important because ancient organisms have a longer track record of adapting to environmental change.

Naeem and colleagues measured these three dimensions of biodiversity in 240 vegetation plots on Black Rock Mountain and quantified their impact, singly and together, on one important aspect of ecosystem function, productivity, as measured by total plant cover. Half the plots (120) were in open for-



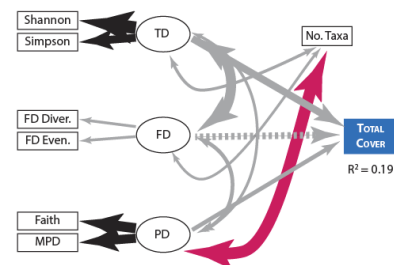
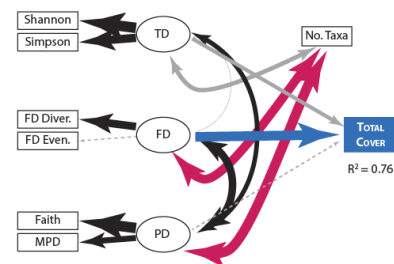
TOP: Shahid Naeem, lead author of 'Biodiversity as a multi-dimensional construct'; ABOVE: Katie T and Sara P conduct research inside deer enclosure

est and half were within fenced deer enclosures that had been erected two years previously. Enclosures protect plants from deer browsing and generally, over time, develop denser vegetation, especially denser and taller stands of woody plants.

The study found that on forest plots exposed to deer herbivory, the plots with higher functional diversity had higher plant growth as measured by cover. Thus it is beneficial to have many differently functioning species present, such as plants with different leaf thickness and strategies for nutrient uptake and the use of light. Functional, phylogenetic and taxonomic biodiversity, taken together, explained three-quarters of the variation in plant cover among the plots exposed to deer. But putting up fences to exclude deer changed those relationships. When not exposed to herbivory, the amount of plant cover produced on forest plots was only poorly related to diversity and more controlled by factors not measured in this study.

The study provided an important take-home message, for scientists and for all of us. Had Naeem and colleagues looked only at taxonomic diversity, as the vast majority of studies do, their study would have yielded little insight into the impacts of deer on vegetation. Their study suggests that while important impacts of biodiversity loss on ecosystems have been demonstrated by prior studies, what we know is probably only the tip of the iceberg.

Until now, we have all been looking at a painting of biodiversity - a flat representation at relatively low resolution. However, if we begin to incorporate multiple measures, we will see more of a sculpture, viewed from all sides, with attributes that were hidden before. The better we understand the complexity of biodiversity in what Naeem and colleagues have called “the heyday of contemporary mass extinction,” the better chance we will have of managing the consequences, and strengthening the case for preventing further losses. 🌿

Vegetation Protected from Herbivory**Vegetation Exposed to Herbivory**

Strength of relationships (wider line = stronger) of taxonomic, functional, and phylogenetic diversity with productivity as measured by total plant cover, (a)- within deer enclosures, (b)- outside of deer enclosures.

Hikes Program Launches! (continued from page 1)**2017 Hikes for Friends and Families**

- **April 15:** Archeology & History
(John Brady and Jack Caldwell)
- **May 6:** Engineering from Nature
(Sam Keany)
- **June 3:** Birding by Ear
(Terryanne Maenza-Gmelch)
- **June 4:** Nature by Ear, Scent and Touch for the Visually Impaired
(Terryanne Maenza-Gmelch)
- **July 15:** High Peaks Hike
(Bill & Eileen Glaser)

RSVP for any of the hikes to Brienne Cliadakis at bcliadakis@blackrockforest.org

New In-Service Training for Newburgh Teachers

Newburgh Enlarged City School District (NECSD) high school teacher Veronica Dunham, along with Consortium Staff Jack Caldwell and Kate Terlizzi, designed an “In-Service” course for NECSD teachers as part of the District’s professional development program. The course is titled “Using Inquiry-based Learning at Black Rock Forest.” Inquiry-based learning puts the teacher in the position of facilitator as students inquire and guide the project or



Jack Caldwell uses tree cookies as a teaching tool with Newburgh teachers.

class. This learning style is well-matched for scientific inquiry, especially in an outdoor setting where the scientist - here the student - is exploring hypotheses.

As an example, Dunham brings her field biology class to Black Rock Forest every spring to investigate the amphibian population. Students arrive having already learned about amphibian habitat requirements. Consortium staff and Dunham help students target their questions about where amphibians might live within the Forest. Students devise ways to find answers to their questions and are guided as they come up with a scientific procedure to test hypotheses, gathering evidence (data), and drawing conclusions. They gain ownership of the project and concrete experience supports their increased knowledge.

On March 4th the first of six in-service trainings was held at Black Rock Forest with 24 elementary, middle and high school teachers seeking to apply what they learn to the different classes they teach ranging from science and special education to art and history. NECSD

teachers will learn to use many of the Consortium’s resources for field and lab experiences, develop confidence teaching outdoors using field research techniques, get to know Forest locations that connect to their curricula, and create interdisciplinary connections. At the end of the course, teachers will submit peer-reviewed lesson plans and activities to be posted on the NECSD website. These lesson plans will be available to anyone with internet access, and can be used by all Consortium members. ♻️

—Kate Terlizzi



Newburgh Teachers set out into the Forest to learn how to incorporate field work into their curricula.

Studying Fish and Water Quality with West Point Cadets

The air was crisp, the sky was blue, and the fish were... stunned. In March, cadets from the United States Military Academy at West Point gathered along Peck’s Road to study water quality and fish distribution along Black Rock Brook. Under the supervision of LTC Mark Smith and Dr. Patrick Baker, senior environmental science students (cadets) Hugh McConnell and Alaina Kappner collected data for an independent study to determine what changes, if any, have occurred since similar data were collected, also with West Point cadets, in 2009-2010, shortly before Hurricane Irene.

In 2009-10, baseline measures of water quality and fish populations were done to study potential effects of road runoff, introduced brown trout, and long-term dams on fish populations along the Brook. This data contributed to an understanding of the health of streams and waterways within Black Rock Forest, and of the distribution of native brook trout in relation to non-na-

tive brown trout which Consortium scientists are concerned can out-compete the native species.

In 2011, Hurricane Irene (downgraded to a tropical storm) made landfall in New York. The storm destroyed dams on Black Rock Brook and other structures in Cornwall, changing the brook’s structure, removing obstacles to fish, and possibly carrying roadside runoff farther than before.



BRFC staff member Matthew Munson electrofishing with senior West Point cadets Alaina Kappner and Hugh McConnell.

Students traveled along the brook to predetermined locations, splitting into two teams: those assessing water quality and those studying fish metrics and distribution. Volunteers from Dr. Baker’s aquatic science course gathered samples in bottles and measured water flow, turbidity, particulates, and other parameters to determine whether runoff impurities have changed over time and where the changes may have occurred.

The other team gathered fish data. BRFC’s Matthew Munson and Jack Caldwell operated electrofishing equipment to temporarily stun the difficult-to-catch fish. Kappner and McConnell collected the stunned fish in a net for other cadets to identify, weigh, and measure, before releasing them back into the brook as the fish recovered. Among the species identified were eels, brown trout, brook trout, black-nosed dace and chub. The data will be interpreted by the cadets and used in their study. ♻️

—Sara J. Pace

The Forest and Its Founders

The Forest has a profound past. The vision of two families, Stillman and Golden, has created a history of opportunity, conservation and knowledge.

Dr. Ernest Stillman inherited a 3,200 acre tract of land in 1918. He established the Black Rock Forest in the autumn of 1927. His mindful actions would make available the land to demonstrate the reclamation of a mistreated forest by means of the relatively new science of forestry. Stillman laid down the ground work for science and public access, creating and upgrading woods roads and trails.

Stillman was well aware of the importance of fresh air. As founder of the Cornwall Hospital in 1931, he had a third story veranda created for patients to breath fresh air while viewing the brilliant vista, once Stillman lands, from Storm King Mountain beyond to Black Rock Forest. Locals know the soul of Stillman's Black Rock Forest. Those whose names are recorded in forest crew ledgers of 100 years ago found woodwork and sub-

sistence during hard economic times. Current generations of the same families now find school and wonder at the Forest.

By 1949, when Harvard University inherited the Forest, science bulletins had been published, and ponds were built. For the next 40 years, a dormant forest benefitted from preservation and silvicultural treatments, resulting in a healthy, beautifully diverse mix of tree species.

By 1989, the Forest's original purpose was slowly becoming a memory. As if by design, the William T. Golden family had become aware of the Forest's potential. Opportunities created by Golden's academic influence drew on his relationships as science advisor to the President of the United States, his chairmanship of the board of the American Museum of Natural History, and his board service for numerous other science institutions. The laborious task of forming an academic consortium required bringing together prominent leaders of education and research with persistence of

communication. Tempered guidance by the Golden's tapped the potential of researchers, students and professionals to learn and communicate in a forest of knowledge. The Consortium coaxed the best of ideas from minds engaged in an environment of unlimited course. Classrooms, labs and a "green" dormitory help interpret the lessons. Hundreds of thousands of students from many walks of life have benefitted from the opportunity to experience Black Rock Forest.

The legacies of the two families continue to be far reaching. First the preservation, conservation and management essential to the environmental legacy, and then the Consortium, missioned "to promote scientific research and excellence in education." The Golden and Stillman families are graced with the sense of the Forest's unique potential to be interpreted by the congregation of educated minds, to enlighten our understanding of the natural world. 🌲

—John Brady

Forest News in Brief

Join us for our May 11 Benefit Luncheon at the Metropolitan Club of New York! Tickets start at \$250. Keynote speakers are Ken Baum and David Krulwich, authors of *The Artisan Teaching Model: Working Together to Transform Your School* and leaders of the Urban Assembly School for Applied Math and Science in the South Bronx. The E.G. Stillman Award for conservation leadership in the mid-Hudson region will be present to Vincent Tianquan Mo, Chairman and CEO of Fang Holdings Ltd., and a Member of the Board of Trustees of the New York Military Academy. To purchase tickets contact Emily Cunningham at the Consortium, 845-534-4517 ext. 26.



Consider spending your summer in forests, restoring our region's trails with the NY-NJ Trail Conference Conservation Corps (An AmeriCorps Program). Up to \$2,800 for college or toward student loans. Free training and housing provided. Visit www.nynjtc.org/corpsmembers for more information.

Central Park Conservancy's "Park before Dark" free workshops for educators continue on May 3rd with "The Heart of the Park: Bethesda Terrace and Fountain," 4:30 — 6:30 pm at the Chess & Checkers House. Discover how nature influences Central Park's built environment, examine the secrets carved into Bethesda Terrace. **To register, visit:** <http://www.centralparknyc.org/about/institute/educator-programs/workshops.html>

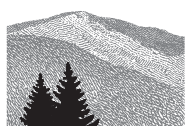
A Forest Welcome to Jack Munson, born on March 9, 2017 to Data/Network Manager Matthew Munson and his wife Tiffany, and to Breen Terlizzi, born on April 8, 2017, to Educator and Research Associate Kathleen Terlizzi and her husband Keith. Congratulations to both families and our future hikers Jack and Breen!



Jack Munson



Breen Terlizzi



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Spring 2017 Newsletter

Report from the Field



While hiking Black Rock Forest, one of my high school students confessed to me that she had rarely walked on grass, been to a forest or even visited a beach. I was never so stunned. My name is Veronica Dunham and I teach Field Biology at Newburgh Free Academy, a city high school located in Newburgh New York. My school district is a member of Black Rock Forest Consortium, and for the past eight years I

have been making it a point to expose my students to the great outdoors. Every year, I bring over 100 students to Black Rock Forest, not only to tread on grass and hike through the woods, but also for scientific inquiry. Before I started taking students, the extent of their experience in the field was the school parking lot; I felt I could do better.

The Forest offers activities that are more engaging and allows me to incorporate more inquiry-based activities into my curriculum. Some of these activities included dendrology studies, long-term tree plot studies, vernal pool amphibian distribution, macroinvertebrate water quality study (using leaf packs), turtle population data, mammal trapping, study of skulls and pelts, and brook trout development.

Over the years, I noticed other benefits from bringing my



classes to the Forest. First, I realized that it is a great way to bond; perhaps because we encourage one another while struggling up Black Rock Mountain. My students' camaraderie continues when we are back in the classroom, not only with me but also with their classmates.

Every September, I start my year by asking my classes about their outdoors experience. More than half of my students have never hiked or visited a forest. This experience is a new adventure; they often ask if they can come back with their family and friends. Many live in the city and they tell me walking around their neighborhood is dangerous. They enjoy the forest. It's peaceful. When experiencing nature at Black Rock Forest, teenagers are allowed to be childlike and let their guard down.

—Veronica Dunham

ABOVE: Veronica Dunham leading a 2016 teacher training.