

## Brief Descriptions of Black Rock Forest Curricula

These brief descriptions of curricula frequently pursued at Black Rock Forest are organized by grade level and subject area. Consortium members may obtain information and curriculum materials from Forest staff.

### Elementary Grades - Pre-Kindergarten to Fourth Grade

#### Life Science

**Animal Tracking.** On a winter hike after a snowfall, students can find evidence of the movements of various forest animals – deer, fox, mice, otter, and turkey. A Black Rock Forest staff person usually leads this hike, but knowledgeable classroom teachers can take this hike with their classes on their own. This experience connects well with classroom work in humanities – literature, creative writing, and visual arts – and can become the culminating activity of an interdisciplinary unit.

**Aquatic Environment.** Black Rock Forest has a variety of aquatic environments for classes to study closely. Students can use seine nets on one of our Forest streams or ponds. They can check on development of frog eggs in a vernal pond. Visits to a pond or reservoir can reveal how the turtles are doing. A pond study introduces students to the aquatic life of insects, salamanders, clams, and leeches. Students can measure the pH and dissolved oxygen levels of each site to get a clearer understanding of how water characteristics impact smaller creatures in the Forest.

**Dendrology.** A close examination of tree leaves and bark reveals the various types of trees in Black Rock Forest. Students learn the distinguishing attributes of leaves that lead to the accurate identification of the tree species. Younger students can collect a pile of leaves to sort, discover leaf attributes and, later, identify the trees. On a dendrology hike, students encounter a wide range of trees to identify.

**Mammals.** Introduction to the mammals of Black Rock Forest begins with a discussion of mammal adaptations using skulls, skins, and pictures. The diverse habitats of mammals are also discussed. Following the lab discussion, it is off to the woods to investigate animal signs and survival strategies in a variety of habitats.

**Seasonal Observation.** A set of visits during each season of the school year enables students to observe and record the changes in the Forest each season brings. Classes can make regular visits to a stream, a wooded plot, or a large or small pond. Students can measure air and water temperatures, describe the trees and plants, and make note of any animal activity.

**Turtles.** Black Rock Forest is home to turtles that live on land and in the water. Years of study of aquatic painted turtles have produced much information about their behavior, population size, sex ratio, and age structure. Turtles, most already electronically tagged, can be captured alive in turtle-safe hoop traps. Students can scan for tags, learn life histories, and perform measurements to complement the ongoing turtle research.

## **Earth Science**

**Water Cycle.** Study of Black Rock Forest watersheds begins with a short hike to follow the water that leaves the Upper Reservoir by way of the Reservoir Brook and continues to the Filter Plant. Using student observations and some good questioning, teachers can lead students to an understanding of the water cycle, moving from the atmosphere to the earth and back. This closed system has no water added to or removed from it. All life depends on the water we have today, which is the same water that people used thousands of years ago.

## **Math and Technology**

**Acorns.** Acorns are a significant source of food for forest animals. A few of the many acorns that fall may become the oak trees of tomorrow. Tracking the production of acorns each year helps predict the health of the Forest and its animal populations. Students learn an important lesson in estimation (and, potentially, tree identification) by counting the number of acorns in a small area and then estimating the amount of acorns produced in the entire Forest.

**Green Building Tour.** The Black Rock Forest Center for Science and Education and the Forest Lodge are called green buildings because they were built to have a more positive impact on the environment than traditional buildings. For example, the buildings are heated and cooled using only heat pumps connected to a well system, and the bathroom toilets are waterless, composting toilets that turn human waste into soil. The concepts behind a green building are intriguing to discuss and impressive to see in reality. For example, how can a building take advantage of the sun's energy – heat and light? Tours allow students to see and learn about these features and the many other special considerations that went into the design and construction of these two special buildings.

**Map and Compass I: Making a Map.** This unit introduces students to the use of a compass. Students become familiar with the basic operation of the compass and use it to create a simple “circle map.” Students learn that the 360 degrees of a circle correspond to the cardinal directions of the compass. The “circle map” places the student in the center of a circle in order to create a map that features the significant objects a student sees in the field. Once students find the correct bearings of several objects, they place the objects correctly on the map. The students determine the accurate direction of an object by using the compass and manipulating the map. Distance is an estimation of how far an object is from the student in the center of the map.

**Measuring Tools.** A variety of different tools and instruments are used to take scientific measurements in the Forest. These measurements must be accurate in order to correctly understand what is being observed. Students are taught to use some of these tools (thermometers, rulers, Biltmore sticks, trundle wheels and measuring tapes, calipers, and pH and dissolved oxygen kits) and to record and interpret the data they collect.

## **Humanities: Visual Arts**

**Art from Nature.** Art from Nature or Environmental Art is created from materials found in the Forest. This variety of materials can be arranged and manipulated into wonderful, though often temporary, art. Structures, sculptures, models, masks, and habitats can all be made using leaves, twigs, pine cones, acorns, clay, etc.

**Drawing and Painting.** Whatever the season, the Forest offers myriad sites for artists of all ages to draw and paint. Crayons, chalk, charcoal, and watercolors can all be used to depict forest scenes, lakes, and ponds.

### **Humanities: Social Studies**

**Historical Hikes.** Two self-guided hikes start at the Stone House (built 1832) and go to either Eagle Cliff or Split Rock. Along the way, written descriptions explain historical highlights and Forest usage. Destinations such as the great White Oak Tree (250+ years old) and Continental Road are remnants from Revolutionary War times.

**Native Americans.** Evidence exists that Native Americans used many sites in Black Rock Forest for seasonal camps. Students can hike to view some of these locations. They can be asked to imagine and reflect upon the time when these sites were occupied.

### **Humanities: Language Arts**

**Creative Writing.** Many of the landmarks and scenic views of Black Rock Forest have inspired poems, legends, and historical short stories. Beautiful vistas, rock formations, waterfalls, and old homesteads supply the settings. All that is needed is the student's imagination.

## **Intermediate Grades: Fourth to Eighth Grade**

### **Life Science**

**Aquatic Invertebrates.** A stream's condition and health can be evaluated by studying the amount and types of aquatic invertebrates living in it. In this class, students sample the stream to collect a selection of the invertebrates. They then identify the organisms and assess the condition of the stream.

**Deer Biology and Management.** This class begins with a classroom discussion using pictures, deer skins, skulls, and antlers to help explain the adaptations of deer and their critical behavior for survival. Students can go on a hike to explore the habitats and needs of white-tailed deer. Scheduled stops include visits to deciduous and conifer stands along neighboring swamps and wetlands. Techniques of tracking and study of deer sign are discussed and practiced, with an emphasis on the deer's annual breeding cycle. The class is best pursued during September, October, and November. Winter classes are possible if the weather permits.

**Dendrology.** Black Rock Forest is home to 65 species of trees and many species of shrubs. A dendrology identification key has been established to enable students to identify 25 of the most common woody species. The key uses leaf anatomy and structure as identification clues. Leaf-out at Black Rock Forest occurs in late April and leaf-fall begins in mid-October.

**Forest Ecosystems.** *This is an interdisciplinary unit with separate write-ups for plant life, wildlife, geology and soils, human impacts, and environmental measurements, which can be pursued together or separately.* A hike leading from the Center for Science and Education to the White Oak Tree includes ten stops, each representing a different habitat found in the Forest. At each stop, Forest staff have collected information about wildlife, plant life, geology and soils, environmental measurements, and human impacts. The theme or themes of the hike should be

chosen by instructors based on the class level and interest. That theme can then continued through the hike. Generally, the wildlife and plant life classes are suggested for younger grades and the others are for more advanced classes. The time needed to complete each class is about 3-4 hours.

**Mammals.** Introduction to the mammals of Black Rock begins with a discussion of mammal adaptations using skulls, skins, and pictures. The diverse habitats of mammals are also discussed. Following the lab discussion, it is off to the woods to investigate animal signs and survival strategies in a variety of habitats.

**Amphibians.** Amphibian life and health are directly related to water availability and quality. Vernal pools, which serve as breeding and developmental locations for a variety of amphibians, are scattered throughout the Forest. During early spring visits (March-May), students can easily discover first amphibian eggs and then larva and adults. Students can use dip nets to collect and observe amphibians and can measure pH, temperature, pool size and depth, and surrounding terrain to correlate species diversity with habitat quality.

**Trout in the Classroom.** *This is a multivisit course, although the program can be observed on a single-day visit.* This intensive hands-on course runs from December through May in concert with the life cycle of New York's only native trout species, the brook trout. Classes can sign up to integrate this into their curriculum or just observe on a day visit. Students observe brook trout in tanks from fertilization through fingerling stages, applying hatchery and lab techniques as a foundation for understanding life cycles, aquatic systems, and the behavior and requirements of aquatic organisms. Participating classes make three winter visits to the Center for Science and Education and three spring visits to the freshwater streams of Black Rock Forest. The program concludes with the introduction (or stocking) of the raised brook trout into a stream environment that has been studied and concluded to be adequate trout habitat.

**Turtles.** Black Rock Forest is home to turtles that live on land and in the water. Years of study of aquatic painted turtles have produced much information pertaining to behavior, population size, sex ratio, and age structure. Turtles, most already electronically tagged, can be captured alive in turtle-safe hoop traps. Students can scan for tags, learn life histories, and perform measurements to assist in the ongoing turtle research.

**Wetlands.** Students discover how wetlands provide many benefits to humans and animals. They will also learn the qualities that characterize a wetland.

## **Earth Science**

**Forest Ecosystems.** *This is an interdisciplinary unit with separate write-ups for plant life, wildlife, geology and soils, human impacts, and environmental measurements, which can be pursued together or separately.* A hike leading from the Center for Science and Education to the White Oak Tree includes ten stops, each representing a different habitat found in the Forest. At each stop, Forest staff have collected information about wildlife, plant life, geology and soils, environmental measurements, and human impacts. The theme or themes of the hike should be chosen by the instructor based on the class level and interest. That theme can then continued through the hike. Generally, the wildlife and plant life classes are suggested for younger grades and the others are for more advanced classes. The time needed to complete each class is about 3-4 hours.

**Map and Compass II: Introduction to Orienteering.** In this unit, students learn how to properly use a compass and map to orient themselves in the Forest. After the initial introduction, during which students learn how to measure distances by pacing, students set off in small groups to complete a compass course. Two compass courses have been set up: one at the Stone House and one at the Center for Science and Education.

**Rocks and Minerals.** The bedrock geology of the Forest is comprised of billion-year-old Precambrian granite gneisses. Hand samples of various rocks from the Forest in which various minerals can be identified have been cut and polished by scientists from the American Museum of Natural History. A geology hike through the Forest (as written up in the Forest Ecosystems unit) allows exploration of erosion and sedimentation, glaciation, and soil formation.

**Watershed Exploration.** Students learn that high-quality surface water is a rare and vital resource that needs to be protected. They discover how plants and animals, human use, and land use all impact the quality of our water. The water cycle is reviewed, emphasizing the movement of water from the atmosphere to the earth, then over and through the earth, eventually returning to the atmosphere.

## **Chemistry**

**Surface Water Testing.** Students measure pH, dissolved oxygen, and temperature along an elevational gradient from Tamarack Pond (elevation 1305 feet) down to Aleck Meadow Reservoir (elevation 1016 feet), and potentially all the way to the Hudson River at sea level. They learn how water quality can be studied, how humans can impact water quality, and how natural filtration through the Forest improves water quality.

## **Math and Technology**

**Environmental Measurement.** The Black Rock Forest Consortium has installed an environmental monitoring network in the Forest, consisting of remote, automated environmental monitoring stations that measure weather conditions, soil and stream conditions, and other environmental parameters. Classes can tour these stations to learn how research-grade environmental data are collected. They can then access archived and real-time data from the network and explore them using a series of digital exercises.

**Green Building Tour.** The Black Rock Forest Center for Science and Education and the Forest Lodge are called green buildings because they were built to have a more positive impact on the environment than traditional buildings. For example, the buildings are heated and cooled using only heat pumps connected to a well system, and the bathroom toilets are waterless, composting toilets that turn human waste into soil. The concepts behind a green building are intriguing to discuss and impressive to see in reality. For example, how best can a building take advantage of the sun's energy – heat and light? Tours allow students to see and learn about these features and the many other special considerations that went into the design and construction of these two special buildings.

**Tree Measurement.** Students learn and practice how a variety of tree and forest measurements, such as height, age, growth rate, and wood volume are obtained. A Biltmore stick is used to measure tree diameter and height, from which wood volume can be calculated and compared to measurements of real wood walls inside the Center for Science and Education. The exercise can be limited to single trees or extended to trees on a 0.1-acre plot to calculate volume per acre and

timber value. These exercises lead naturally to discussions of natural resources, forestry, and other land uses.

### **Humanities: Visual Arts**

**Art from Nature.** Art from Nature or Environmental Art is created from the materials found in the Forest. This variety of materials can be arranged and manipulated into wonderful, though often temporary, art. Structures, sculptures, models, masks, and habitats can all be made using leaves, twigs, pine cones, acorns, clay, etc.

**Sketching and Painting.** Whatever the season, the Forest offers myriad sites for artists of all ages to draw and paint. Crayons, chalk, charcoal, and watercolors can all be used to depict forest scenes, lakes, and ponds. The dramatic landscape of the nearby Hudson River, inspiration for development of the Hudson River School, can readily be incorporated into trips.

### **Humanities: Social Studies**

**Ethnobotany.** A general knowledge of forest dendrology can be helpful in understanding the great variety of useful goods and products that come from forests. Hikes along any of the many trails can be used to identify plants and both their historical and modern uses.

**Historical Hikes.** Two self-guided hikes start at the Stone House (built 1832) and go to either Eagle Cliff or Split Rock. Along the way, written descriptions explain historical highlights and Forest usage. Destinations such as the great White Oak Tree (250+ years old) and Continental Road are remnants from Revolutionary War times.

### **Humanities: Language Arts**

**Creative Writing.** Many of the landmarks of Black Rock Forest have inspired poems, legends, and historical short stories. Beautiful vistas, rock formations, waterfalls, and old homesteads supply the settings. All that is needed is imagination.

## **High School Level: Ninth Grade to Twelfth Grade**

### **Life Science**

**Aquatic Invertebrates.** A stream's condition and health can be evaluated by determining the amount and types of aquatic invertebrates living in it. Students sample streams to collect a selection of the invertebrates. Then they identify the organisms and assess the condition of the stream by constructing indices such as the EPT and Biotic Index. This information can be combined with water chemistry and physical measurements to provide a full stream assessment.

**Biodiversity.** In this hands-on class, students quantify and compare the woody plant diversity of two or more Forest plots with different historical land uses. Students calculate and compare species richness and the relative abundance of woody tree species and draw conclusions about the relationships between land use and biodiversity.

**Dendrology.** Students can learn to distinguish woody plant species using leaf and bark characteristics in concert with a dichotomous key. They can then test their skills on a test course

with numbered trees. Teachers can adjust this course to accommodate the difficulty level that is needed for their students. For example, a more challenging activity can be pursued in late fall through early spring, keying out species using only bark, twig and bud characteristics.

**Forest Ecosystems.** *This is an interdisciplinary unit with separate write-ups for plant life, wildlife, geology and soils, human impacts, and environmental measurements, which can be pursued together or separately.* A hike leading from the Center for Science and Education to the White Oak Tree includes ten stops, each representing a different habitat found in the Forest. At each stop, Forest staff have collected information about wildlife, plant life, geology and soils, environmental measurements, and human impacts. The theme or themes of the hike can be chosen by an instructor based on the class level and interest. That theme can then be continued through the hike. Generally, the wildlife and plant life classes are suggested for younger grades and the others are for more advanced classes. The time needed to complete each class is about 3-4 hours.

**Mammals.** Introduction to the mammals of Black Rock begins with a discussion of mammal adaptations using skulls, skins, and pictures. The diverse habitats of mammals can also be discussed. Following the lab discussion, it is off to the woods to investigate animal signs and survival strategies in a variety of habitats.

**Ornithology.** Black Rock Forest has a complete Forest bird list, binoculars, field guides, and audio learning tapes to assist teachers and their students with this very popular field study. Peak times for study are spring warbler migrations (April-May), fall migrations (September-October), and winter bald eagle observation (December-March). Students can closely observe birds at feeding stations located at the Center for Science and Education and at the Stone House.

**Turtles.** Black Rock Forest is home to a variety of aquatic and terrestrial turtles. Years of study of aquatic painted and snapping turtles have produced much information pertaining to behavior, population size, sex ratio, and age structure. Turtles with electronic tags can be sampled with basking and baited hoop traps. Students can then scan them for tags and weigh, measure, and identify the sex of the turtles. In the classroom, students can examine historical turtle data and then use their own data to estimate population size (mark-recapture) and other parameters.

**Watershed Exploration.** Students learn that high-quality surface water is a rare and vital resource that needs to be protected, and that plants and animals, human use, and land use all impact the quality of our water. The water cycle is discussed, emphasizing the movement of water between the earth and atmosphere.

**Wetlands.** Students learn that wetlands provide many benefits to humans and animals. They also learn the conditions that characterize a wetland. Students can document wetland plant species by observing species composition on a transect and then comparing it to that of adjacent uplands, and can view and discuss their adaptations. They can examine characteristics of wetland soils, including field capacity, organic matter content, and mottling. Characteristic wetland animals can also be studied.

## **Earth Science**

**Forest Ecosystems.** *This is an interdisciplinary unit with separate write-ups for plant life, wildlife, geology and soils, human impacts, and environmental measurements, which can be pursued together or separately.* A hike leading from the Center for Science and Education to the White Oak Tree includes ten stops, each representing a different habitat found in the Forest. At

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**Geology and Soils.** Evidence of earth processes can be productively studied in natural forest settings. Students can examine specimens of igneous, sedimentary, and metamorphic rocks by eye and under a lens and test them to determine mineral composition. The genesis of the bedrock, 1+-billion-year-old granite gneiss, is described in materials prepared by curators from the American Museum of Natural History's Department of Earth and Planetary Sciences. Polished hand samples can be examined. Classes can also study Pleistocene and Recent changes to the geology and topography, including glacial erratics and deep glacial till deposits. They can examine comparative soil pits to discover how different soils have developed in different locations, substantially impacting community type and productivity.

**Glaciers and Erosion.** Pleistocene glaciers covered the northeast for most of the last several million years. Students can view many different types of physical evidence in the field, including large erratic boulders, deposits of glacial till, and evidence of glacial scouring. Since glacial retreat, erosion has been a major force shaping the landscape, continuing up to this day. Students can easily observe evidence of wind and water erosion and downslope movement of materials, as well as deposition and accumulation of sediments in ponds and low-lying areas. They can estimate sedimentation rates from sediment depth measurements.

**Orienteering.** Students learn how to properly use a compass and a map to orient themselves in the Forest. After an introduction to the compass and learning how to measure distances by pacing, students set off in small groups to complete a compass course. Two compass courses have been set up: one at the Stone House and one at the Center for Science and Education.

**Rocks and Minerals.** With its shallow soil and rocky terrain, Black Rock Forest is ideal for studying rocks and minerals. One of the best areas for this is the rock slide on the south side of Mt. Misery. The majority of the rocks found in Black Rock Forest are metamorphic, though many sedimentary rocks were deposited by glaciers. Hand samples of various rocks from the Forest in which various minerals can be identified have been cut and polished by scientists from the American Museum of Natural History.

**Weather and Climate.** Black Rock Forest's weather records date back to 1959, and air temperature and precipitation records from a nearby station at the US Military Academy at West Point date back to the early 1800s. Many of these data are available online and students can analyze them to examine long-term change and, by viewing them along with other long-term records, can compare, for example, New York City's weather to that of the Forest. Classes can visit Black Rock's remote, automated environmental monitoring stations to see digital sensors, dataloggers, and radiotelemetry equipment used in modern climate stations. Online tools and digital exercises have been developed to allow students to explore data sets and visualize relationships among different climate variables.

**Hydrology.** The hydrologic cycle can be studied in detail in natural watersheds. Black Rock's weather stations provide accurate data on precipitation (P) inputs. Students can directly estimate stream discharge (D) from field measurements (flow, cross-sectional area), convert these to



seasonal estimates, and compare them to the Forest's stream gauge records. Assuming a zero change in storage, actual annual evapotranspiration (ET) can be estimated as  $P - D$ . Classes can make field visits to examine the construction and operation of a stream gauge station and associated meteorological stations; online data sets are available for analysis. A dedicated 400-foot deep well can be used to study groundwater depth, chemistry, etc.

## **Chemistry**

**Surface Water Testing.** Students measure pH, dissolved oxygen, and temperature along an elevational gradient from Tamarack Pond (elevation 1305 feet) to Aleck Meadow Reservoir (elevation 1016 feet), stopping four times. These trips can be extended if time allows down to the Hudson River at sea level. Through their observations, students develop an understanding of natural water filtration and its impacts on plant and animal life, including human populations.

## **Physics**

**Environmental Measurement.** The Black Rock Forest Consortium has installed an environmental monitoring network in the Forest, consisting of a series of remote, automated environmental monitoring stations that measure weather conditions, soil and stream conditions, and other environmental parameters. Classes can tour these stations to learn how research-grade environmental data are collected. They can then access archived and real-time data from the network and explore them using a series of digital exercises.

## **Math and Technology**

**Forest Mensuration.** Determining the wood volume in a forest tree or stand, the value of a woodlot, and the amount of wood materials used in construction of a building are all real-world mathematical exercises. Students can survey fixed plots established in the Black Rock Forest with tools such as Biltmore sticks and diameter tapes to calculate wood volume, using species-specific equations. They can calculate timber values using current wood price tables. Increment cores can be used to quantify age, enabling growth rate calculations, and size-structure analysis can indicate future stand composition. Students can also calculate the amount of wood used in the Forest's green buildings and compared it to Forest volume and productivity to estimate the amount of forest represented in a typical building.

**Using the GPS.** In this introductory class, students learn how to operate a GPS (Global Positioning System) unit. It is recommended that students who take this class also participate in the Orienteering course.

**Green Building Tour.** The Black Rock Forest Center for Science and Education and the Forest Lodge are called green buildings because they were built to have a more positive impact on the environment than traditional buildings. For example, the buildings are heated and cooled using only heat pumps connected to a well system, and our bathroom toilets are waterless, composting toilets that turn human waste into soil. The concepts behind a green building are intriguing to discuss and impressive to see in reality. For example, how best can a building take advantage of the sun's energy – heat and light? Tours allow students to see and learn about these features and the many other special considerations that went into the design and construction of these two special buildings.

### **Humanities: Visual Arts**

**Photography.** The forest, mountaintops, and ponds of Black Rock Forest are excellent places to pursue photography, using black-and-white and color film or digital cameras.

**Sketching and Painting.** Whatever the season, the Forest offers myriad sites for drawing and painting for artists of all ages. The dramatic landscape of the nearby Hudson River, inspiration for development of the Hudson River School, can readily be incorporated into trips.

### **Humanities: Social Studies**

**Ethnobotany.** A general knowledge of dendrology is helpful. Hikes along any of the many trails can be used to identify plants and their historical and modern uses.

**Historical Hikes.** Two self-guided hikes start at the Stone House (built 1832) and go to either Eagle Cliff or Split Rock. Along the way, written descriptions explain historical highlights and Forest usage. Destinations such as the great White Oak Tree (250+ years old) and Continental Road are remnants from Revolutionary War times.

### **Humanities: Language Arts**

**Creative Writing.** Many of the landmarks of Black Rock Forest have inspired poems, legends, and historical short stories. Beautiful vistas, rock formations, waterfalls, and old homesteads supply the settings. All that is needed is imagination.

## **Undergraduate and Continuing Education**

### **Living Environment**

**Aquatic Invertebrates.** A stream's status and ecological health can be quantified based on the types and relative abundance of aquatic invertebrates living in the stream zone. Students use several different sampling methods in different parts of streams to collect aquatic macroinvertebrate fauna. Then they use taxonomic keys and microscopes to identify organisms and construct numeric indices such as the EPT and Biotic Index. This information can be combined with water chemistry and physical measurements to provide a full stream assessment.

**Biodiversity.** Students compare the diversity of two different Forest plots, including species richness and the relative abundance of tree species.

**Deer Biology and Management.** The Black Rock Forest excels as deer habitat and as a location for deer population management. This class begins with a one-hour lecture at the Stone House. Pictures, animal skins, skulls, and antlers help explain the adaptations of deer and their critical behavior for survival. After a short break, students take a one-hour hike to explore the habitats and needs of white-tailed deer. Scheduled stops include visits to deciduous and conifer stands along neighboring swamps and wetlands. Techniques of tracking, with study of deer sign, are discussed and practiced, with an emphasis on the deer's annual breeding cycle. The class is best pursued in September, October and November. Winter classes are possible if weather permits.

**Ecological Field Methods.** This course provides hands-on instruction in common field methods used to assess ecosystem status and health, while familiarizing students with the flora and fauna of the local region. Students learn techniques for monitoring soil and water systems and plant, amphibian, and bird communities. These techniques are applied in a comparative study of forest plots in different stages of succession, all located in Black Rock Forest

**Introduction to Forest Research.** Black Rock Forest has been the site of various forest research projects since 1930. Some of the earliest experiments are still yielding results due to designs that included controls and replication. Using information from the Forest database, students can tour various “treatment” sites and quantify the long term results. Examination of more recent experimental areas demonstrates how the focus of research projects has changed over time.

**Mammalogy** Black Rock Forest provides an excellent field location in which to study adaptations and behavior of eastern deciduous forest mammals. Hand samples of a wide variety of mammal skulls, bones, and skins are available to examine in detail in the lab as well as pictures. Nearly two decades of deer population and associated biological data are available for analysis. Mammal tracks, scat and other signs can be studied in the field with Forest staff using equipment such as spotting scopes and remote infrared-trigger cameras.

**Ornithology.** Black Rock Forest has a complete Forest bird list, binoculars, field guides, and audio learning tapes to assist teachers and their students with this very popular field study. Peak times for study are spring warbler migrations, fall migrations, and winter bald eagle observation. Students can closely observe birds at feeding stations located at the Center for Science and Education and at the Stone House.

**Tree Rings.** Tree rings indicate the integrated growth response of trees to a full suite of ecological and environmental factors. Dendrochronology quantifies time: growth relationships of trees and forest stands and can be used to study past climates and other factors such as disturbance events. Students can examine tree rings from samples under microscopes to see the seasonal morphological changes that produce visual annual rings and can measure their width over a period of years using highly precise equipment. Once a chronology is established and rings are accurately dated, students can quantitatively explore climate-growth and other relationships.

**Turtles.** On a single day trip, students can learn how turtle research is accomplished in Black Rock Forest. Students examine various traps used in the ponds and the turtles (if any) taken from the traps. Students then check each turtle for recapture marks and tags, make measurements, and determine sex. In the classroom, students can view the turtle data that have been collected over the past several years and conduct studies using the population data.

**Wetlands.** Students learn that wetlands provide many benefits to humans and animals. They also learn the conditions that characterize a wetland. Students can document wetland plant species by observing species composition on a transect and then comparing it to that of adjacent uplands, and can view and discuss their adaptations. They can examine characteristics of wetland soils, including field capacity, organic matter content, and mottling. Characteristic wetland animals can also be studied.

## **Earth Science**

**Hydrology.** The hydrologic cycle can be studied in detail in natural watersheds. Black Rock’s weather stations provide accurate data on precipitation (P) inputs. Students can directly estimate

stream discharge (D) from field measurements (flow, cross-sectional area), convert these to seasonal estimates, and compare them to the Forest's stream gauge records. Assuming a zero change in storage, actual annual evapotranspiration (ET) can be estimated as  $P - D$ . Classes can make field visits to examine the construction and operation of a stream gauge station and associated meteorological stations; online data sets are available for analysis. A dedicated 400-foot deep well can be used to study groundwater depth, chemistry, etc.

**Orienteering.** Combined use of map and compass can enable students to travel between exact locations on the landscape, navigating by taking bearings on prominent natural features and by using triangulation and other orienteering techniques. Specific courses can be established in the field to test students' ability to travel in this fashion over a set amount of time or in a timed competition.

## **Chemistry**

**Biogeochemistry.** Weather conditions and human activities all around the world affect the environment. Biogeochemistry examines biological, geological, and chemical processes and their interactions and impacts on soils, water, and the atmosphere. At Black Rock Forest, students are able to sample the soils, streams, and ponds to see the effects of acid rain and snow and the response of the Forest systems. Input-output budgets can be constructed for key biogeochemical cycles.

## **Math and Technology**

**Environmental Measurement.** The Black Rock Forest Consortium has installed an environmental monitoring network in the Forest, consisting of a series of remote, automated environmental monitoring stations that measure weather conditions, soil and stream conditions, and other environmental parameters. Classes can tour these stations to learn how research-grade environmental data are collected. They can then access archived and real-time data from the network and explore them using a series of digital exercises.

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**Green Building Tour.** The Black Rock Forest Center for Science and Education and the Forest Lodge are called green buildings because they were built to have a more positive impact on the environment than traditional buildings. For example, the buildings are heated and cooled using only heat pumps connected to a well system, and our bathroom toilets are waterless, composting toilets that turn human waste into soil. The concepts behind a green building are intriguing to discuss and impressive to see in reality. For example, how best can a building take advantage of the sun's energy – heat and light? Tours allow students to see and learn about these features and the many other special considerations that went into the design and construction of these two special buildings.

## **Humanities: Language Arts**

**Creative Writing.** Many of the landmarks of Black Rock Forest have inspired poems, legends, and historical short stories. Beautiful vistas, rock formations, waterfalls, and old homesteads supply the settings. All that is needed is imagination.